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SAE OFFICES

Headquarters

29 West 39th St. New York, N. Y.
Telephone: Longacre 5-7170

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Telephone: Vandike 3915

E. F. Lowe, Asst. Gen. Mgr.

Detroit Branch Office for War Activities

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R. C. Sackett, Staff Representative

SAE Journal
Editorial Office

29 West 39th St. New York, N. Y.
Telephone: Longacre 5-7174

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CONTENTS

NOVEMBER 1942

THE ARMY AIR FORCES

by

LT.-GEN. H. H. ARNOLD

Commanding General, Army Air Forces

Official photograph, U. S. Army Air Forces

THE armed forces of the United Nations are undertaking what is generally regarded as the most difficult and exacting of all military operations. They are shifting from the defense to the attack.

The act of doing this is, perhaps, the most crucial step in the history of the world. On every continent, in every ocean, in every cubic yard of sky, our forces are ready to lunge forth in the greatest comeback of all time. The success of this whole operation depends in large part on American Air Power. So far, we have not had much of a chance to demonstrate to the world our enormous potentialities. Wherever our aerial forces have already engaged, they have to be sure, given a superb account of themselves. But these have been but a prelude to the main show. Soon we will

have plenty of opportunity of testing the full massed effect of our air arm; the strength and extent of that arm will continue to increase until this war is won.

In later years, when we look back on the course of this war and find that we have come from relative weakness in the air to a state of rapidly increasing power on several major fronts in less than a year, the achievement will loom as little short of a miracle. We found ourselves in the disastrous position of having a global war on our hands with very little with which to fight back. By the exercise of monstrous treachery, the Japs launched a crippling blow at Pearl Harbor. Honesty and decency in the family of nations was the chief cause of our initial disaster. At Hickam Field in Hawaii, at Clark and Nichols Fields in the Philippines, our combat aircraft were smashed on the ground, helpless to defend themselves against the sudden, deadly assault from the skies. Our naval power was rendered immobile, not for very long, but long enough to give the Japs mastery of the Pacific during their quick conquests.

Military Planning Ahead

Fortunately our military planning was considerably ahead of our Country's thinking at large, which was in terms of a continental United States, lulled to sleep in a mistaken security afforded by broad oceans. Our leaders had some realization as to the vital need of building up a strong air defense. In April, 1939, an Air Corps expansion program was inaugurated with provision for 5500 airplanes. Our training program for air crews and ground crews was greatly enlarged. With the outbreak of war in September, 1939, the British and French placed substantial orders for planes and engines which resulted in an expansion of our aircraft plant facilities.

After the German smash through the Low Countries and the fall of France, a campaign in which air power proved over and over again to be a decisive factor, the President called for a production of 50,000 airplanes per year. This was in June, 1940, when funds for 3000 planes were provided, and by early fall contracts for the first 12,000 Army airplanes, with engines and accessories, were let, and a few months later 6000 more. During 1941, our training programs were further stepped up to provide an Army Air Force organization of 84 expanded groups, with 40,000 officers and 600,000 enlisted men.

Thus by December, 1941, we were getting into second-gear in the matter of air power, and this headstart enabled us to throw our effort into high gear within a few weeks of our entrance into the war. As of June, 1941, the Army Air Force had attained a semi-autonomous status, and early in March, 1942, the entire Army was streamlined by a reorganization into three main branches: The Air Forces, the Ground Forces, and the Services of Supply, each headed up by a lieutenant general responsible only to the Chief of Staff, U. S. Army. At this time, it was announced by the War Department that the Army Air Forces would be expanded to an ultimate total of 2,000,000 officers and men, with a goal of half that number during the current year. In the meantime, the President had again raised the sights on aircraft production by calling for 60,000 planes during 1942 and 125,000 in 1943. Of these, 148,000 airplanes were for the Army Air Forces, and contracts for these have been placed, with the hundreds of thousands of high-powered aircraft engines and millions of instruments and gadgets.

However, much of this was still future on Dec. 7, 1941, and although the sudden attack by the Japs at various points in the Pacific aroused our nation to some extent, as a whole our country is still far from realizing the danger we were in then, and are in even yet. We have had a large amount of first-hand evidence as to the Japanese plans for domination of the Pacific and Asia generally, and their character, as tough and ruthless fighters. We had been strengthening our air position in the Philippines, and given a few more weeks we might have had enough there to turn the trick, but they found out what was going on and struck first. We not only lost most of our small but growing air force, but our transpacific aerial supply line as well, with stepping stones at the Hawaiians, Midway, Wake and Guam.

Our air power was spread dangerously thin all over the world; nowhere did we have enough strength at any one place to do the job. Millions of troops and thousands of airplanes were so far from the scene of action that we faced a major job of transportation to get them where they were so desperately needed. The loss, for the time being, of so much of our air power in the Pacific and the damage to our naval units constituted a vicious circle. Without the air power to protect the naval craft to convoy our sea-borne transport, it was almost impossible to send to the zone of action more air power, or anything else, for that matter.

We began to overcome this difficulty by expanding our air transport facilities. In June, 1941, the Air Corps Ferrying Command had been started to speed up deliveries of our planes from the factories to the points of departure from our shores. Within six months over 1000 airplanes were thus delivered, with an amazingly good safety record, and a beginning made of overseas operations. The groundwork of a highly efficient air transport service had been laid, capable of almost endless expansion. Before long a new air route over the South Pacific was operating, and another across the South Atlantic via Brazil, to Africa, and from there to Iran-Russia or India-China. Now operating as the Air Transport Command, other routes have been developed, including the west coast-Alaska and beyond, and to England via the North Atlantic, Greenland, etc. Bringing our established airlines into the picture, the Air Transport Command is now operating a world-wide air service which carries men, materiel and mail to all the fighting fronts. Modern war moves fast, and air transport enables us to rush urgently needed men and supplies to meet hot situations, an increasingly valuable auxiliary to ocean transport.

Transport Operations Widespread

Incidentally, the widespread operation of the Air Transport Command was probably expressed most cogently the other day by a young navigator who had been doing quite a lot of intensive ferry flying. When asked by a friend where he and his crew had been during the past few months, he replied: "Well, I think we've been every place there is to go, except Germany, Japan, and Italy. But we're working on *that* now!"

Thanks to the Air Transport Command and the wisdom displayed by our land, sea, and air commanders in the zone of action, we rebuilt our striking power. By refusing to be stampeded into disastrous premature moves that would have jeopardized the whole undertaking, by reinforcing our strength, repairing our combat forces, and husbanding

our resources until we could employ them with potent effect, we managed to do what the Japs never thought we could do. We regained the balance of power in the Pacific. Coral Sea and Midway are proof of that. We are pointing now toward the time when we will be able to fight the Japs in force in the air, on the sea, and on the land. When the Japs ever do come to grips with us in a major battle, the outcome will be certain. And all the American soldiers, sailors, and airmen ask for, is the chance to show what they can do.

American Performance Superb

In every major engagement where the Americans have been offered anything like even odds, they have proved to be superb. We have no doubt of the quality of our men or airplanes. Our flyers have been trained in the most thorough flying course in the world. After each member of the air crew, such as the bombardier, navigator, pilot, aerial gunner, has had his specialized training as an individual, a period of several weeks known as Operational Training is given, during which time these boys learn to function as a smoothly working team. No other nation on earth can afford the flying time that our men receive in training. Neither, for that matter, does any other nation have the fuel available. In safety provisions, both in training and in combat, our aircraft are second to none.

Every American combat airplane is full of "plus" values that make for greater safety, reliability and combat efficiency. These features seldom show up on paper in a specification comparison with aircraft of other nations. Many of them are secret, and we will not be goaded into giving them away. We will not remove an ounce of heavy armor that protects our flyers from enemy bullets, we will not endanger the lives of our men by buying added range at the cost of life-saving self-sealing gasoline tanks, we will not buy altitude at the cost of removing certain devices that add immeasurably to the efficiency of our machine guns and power turrets.

We want *both* safety and performance in our combat aircraft, and we are getting both. The remarkable achievements of the famous American heavy bombers, over Tokyo, the north shore of Australia, in the great Pacific sea-air battles, and now in North Africa, and over Europe, prove that we have been successful. The skilled flyers of the RAF have already expressed amazement at the daylight bombing accuracy which our bomber crews have achieved. And they have been even more impressed with the ability of these airplanes to fly through heavy enemy fighter and anti-aircraft fire, drop their lethal loads, and return safely to base, despite repeated hits by machine-gun and cannon fire.

When the flyers of the RAF, who certainly know a thing or two about this business of air warfare, pay such compliments to the AAF, it is high praise indeed. Professional airmen know well the worth of the "hidden" features of American aircraft, features that cut to a minimum the dangers of engine failure, that enable the airplanes to carry on with half their engines functioning; they appreciate the structural integrity that makes it possible for our aircraft to absorb heavy fire and stand up under conditions that would wreck inferior planes. We call these "hidden" features, but you may be quite sure that our enemies would like to uncover just what it is that makes our airplanes hold together when the going gets tough.

Another important feature of American bombers, that is not obvious, is their capability of high altitude daylight precision bombing. This is a result of a definite American air power strategy worked out years ago. From this we see now the full fruition of such ideas as the heavy bomber as the backbone of a striking air force, with the Boeing B-17, *Flying Fortress,* as the successful guinea pig. This remarkable long range bomber was developed by the Air Corps in 1935-36, and by mid-summer 1937 thirteen of the original YB-17's were in service. During 1938, experiments were made with one of them equipped with turbo-supercharger for high altitude performance, and in January, 1939, was successfully flown as the world's first substratosphere bomber. In August of that year, as part of the 30th anniversary celebration of the Army Air Corps, several of these B-17B's smashed several international records for carrying heavy payloads over long distances and at high altitudes. Continued improvements in the way of leak-proof gasoline tanks, armor protection, and devastating fire-power from all angles have produced our present B-17E which in various combat areas has turned in a record as a heavy bomber and a deadly fighter which has dismayed our enemies and amazed our friends.

Concurrent with these developments, and as additional elements of American air doctrine, work on the precision bombsight, and the emphasis on teamwork in heavy bomber missions, including aerial navigation, was continued. The results of all these pre-Pearl Harbor developments are now beginning to show big dividends in the southwest Pacific, in the hitherto small but effective air offensive operations in China, in the fierce struggle in the Midde East sector, and over the Continent of Europe.

Bombing Germany

Since spring the RAF Bomber Command has been carrying out an increasingly successful series of devastating night raids on the industrial centers of Germany, on the basis of highly concentrated attacks by hundreds of heavy bombers known as area bombardment. Heavy damage has been done to factories, communications and power facilities and an increasing disruption of Germany's war effort is certain to result. In June, this country officially announced that the American Air Force would team up with the RAF, with American air crews flying American planes as American units, using bases manned by American ground technicians. This cooperation has already begun and the first use of the *Flying Fortresses,* both with and without fighter plane protection, has abundantly justified our doctrine of daylight precision bombing. This will be continued on an ever-increasing scale, and will be a valuable supplement to the RAF Bomber Command's heavy night raids. Each type of bombing has its place in the air war. As a matter of fact, if it appears advisable later on to use some of our heavy bombers as the British have been using theirs, which were specially designed to carry heavy loads relatively short distances at medium altitude, this can be done by overloading our B-17's and B-24's with bombs and underloading them with fuel.

Our air operations in the various areas are small right now compared with what they will be a year from now. The productive capacity of America's aircraft industry, supplemented by the automotive industry and widespread

turn to page 64

NAVAL AVIATION AT WAR

by

VICE-ADMIRAL J. H. TOWERS

Commander of Air Force, Pacific Fleet, U. S. N.

Official U. S. Navy photograph

ALMOST a year has passed since Japanese aircraft rang up the curtain on this war by striking at Pearl Harbor, with consummate treachery and skill. In that year naval aviation has expanded with the rapidity of a bomb explosion. Seeming impossibilities have been accomplished in planning, personnel, training, production.

For fulfilling the Navy's 30,000-pilots-a-year-program, four pre-flight physical training centers have been set up at colleges or universities taken over for the duration. Eighteen primary training stations at Naval Reserve Aviation Bases scattered over the country, most of them with a student capacity of 800, are carrying the initial load of flight training. Intermediate training is concentrated at Corpus Christi and Pensacola. Advanced training, at Naval Air Stations at Jacksonville and Miami, Fla., in service types – fighters, torpedo planes, patrol planes, dive bombers – teaches the pilot those professional skills he will use against the enemy: carrier work, fixed and free gunnery, bombing, radio, navigation, formation tactics, and a dozen other aerial subjects. The Operational Training Command, with headquarters at the U. S. Naval Air Station, Jacksonville, Fla., has been established and eventually will include some twenty strategically located air stations or training units. Of interest in this regard is the conversion of a twenty-knot side-wheeler, the *Seeandbee,* into a training carrier for use on the Great Lakes. Service and technical schools of a dozen types are training mechanics, radiomen, ordnance men, and other specialists in those many arts and trades which are necessary to "keep 'em flying," keep our planes in the air.

All this is highly secondary; the most vital phases of naval aviation at war are, of course, operations against the enemy. These involve offensive and defensive patrols which extend over the world's oceans from the Antipodes to the Arctic, air stations from Iceland to the South Seas, naval air transport and a dozen kindred aerial jobs, and the striking missions of task forces built around our aircraft carriers.

The aircraft carrier task force has so far been the most spectacular and effective weapon employed against Japanese ships and shore facilities. Such a Task Force consists, usually, of one or more carriers, their flight decks loaded with offensive torpedo planes and dive bombers and offensive and defensive fighters. Other units of the Task Force are light or heavy cruisers and other surface craft, depending on the mission in hand. Their function is to protect the carriers, repel enemy surface craft and, at times, bombard shore bases. Such a Task Force moves at high

speed; it packs an offensive punch; it is defensively strong in anti-aircraft fire and against enemy submarines.

With the exception of Taranto, the first use of an aircraft carrier task force in this war was by the Japanese at Pearl Harbor. Later our own Navy employed aircraft carrier task forces in the highly successful raids against the Marshall and Gilbert Islands and against Wake and Marcus. In the battle of the Coral Sea, on May 7 and 8, aerial scouts from two such task forces, one Japanese, one United States, made contact. Radios crackled urgently, air groups received their orders, planes rolled down the flight decks, joined up and headed for their respective objectives. For the first time in history, opposing aircraft carriers, almost 200 sea miles apart, were coming to grips in that struggle to destroy and survive which is the final test of air and seapower.

■ Zeros Shot Down

Our dive bombers and torpedo planes drove in, ignoring Japanese anti-aircraft fire, to ranges so close it seemed they would strike the enemy ships, as their fighter escorts fought off and shot down many enemy Zeros. On May 7 one Jap carrier was blasted to destruction; on May 8 two Japanese carriers were attacked, one possibly sunk, one badly damaged. On this latter date Japanese dive bombers and torpedo planes, heavily escorted by Zeros, fought their way through our defensive patrols and inflicted fatal damage on the *Lexington*. The toll of Japanese aircraft shot down was high.

At Midway again, a Japanese aircraft carrier task force was met and virtually annihilated by our own carrier-based dive bombers, fighters, and torpedo planes – a point worthy of note at a time when much talk about the land-based bomber is being bandied about. Four Japanese carriers were sunk. Later, as our carriers closely pursued the enemy, six cruisers and destroyers were sent to the bottom.

The operations of aircraft carrier task forces are not new to United States naval aviators. Ever since our first carrier, the small, slow *Langley*, more recently converted to a seaplane tender and sunk by Japanese bombs South of Java, joined the Fleet in 1924, our Fleet exercises, problems, and war games have called for the planning, rehearsal, and execution of exactly such tasks. These were normally carried out against an "enemy" task group drawn from our own forces, similar in composition and resourcefulness to the real enemy we then expected some day to encounter in actual war. On many occasions realistic carrier duels in war games prepared United States naval aviators for air force actions like Coral Sea and Midway, where the stakes were so much higher.

Those years of training are now proving their value. Through them pilots and crews developed skill, speed, and teamwork in flight-deck operation that has never been approached in foreign navies; through them air group and squadron commanders and pilots were brought face to face, year after year, with the problems of the offensive and defensive missions they are now brilliantly executing against the enemy; and through them senior naval aviators developed that combination of sea and air-going experience that is essential to aircraft carrier command and aggressive air leadership.

The test of battle has proved that our methods of peacetime training for war were sound. Recognition of ships and their formations, radio silence to gain surprise, overseas navigation regardless of weather, attacks on fast maneuvering surface craft – such things can be learned only by long air experience at sea. The gunnery approaches used by single-seater fighter pilots, dive bombing and torpedo attack methods worked out against harmless peacetime targets have proved to be completely effective against enemy air and surface opposition.

The same has proved true of our aircraft, their types and distribution, and their complex equipment. Dive bombers and torpedo planes, now being delivered to the Fleet, are the best in the world. Our fighters have proved their superiority over the Zero in offensive fire power and ability to survive every time they have met. Our fighter pilots come home after combat. The Japs do not. New aircraft of all types now moving down the production lines will surpass anything the world has yet seen in performance and fighting ability.

Naval aviation at war presents a complex, fast moving, rapidly changing picture of personnel, shore stations, ships and aircraft.

The problem, for example, of getting planes built for our fliers has been of paramount concern to the Navy. American industry's efforts in the solution of that problem deserve all possible credit.

Let us examine for a moment the history of the aircraft industry for the past few years. Before the war started in 1939, the airplane was a strictly tailor-made affair; there was no production problem, because few planes were made and each one was built to the specifications of the buyer, or according to the ideas of the experimental or design engineer.

But as soon as the war began, air power became a vital necessity to all the belligerents, and some of them at once contracted to buy great numbers of American-built planes. For the first time in aviation history, quantity and time were the crucial factors in airplane manufacture. The entire habit of thought, system of planning, method of procurement of the whole industry had to be re-oriented overnight. And no sooner was it moderately well-set than the Lend-Lease program trebled its obligation; at the same time, adverse fortunes of war began to be felt in obtaining some of the necessary materials.

Finally, Pearl Harbor brought the demands of an

Special!

Vice-Admiral Towers' post as Commander of Air Force, Pacific Fleet, was newly created about the middle of September.

Written specially for the SAE Journal while he still held the post of Chief of the Navy Bureau of Aeronautics, this article holds additional interest in light of the important promotion just given him.

Admiral Towers is the first combat pilot to achieve rank above that of rear admiral – and in addition to his new command becomes ex-officio adviser to Admiral Chester W. Nimitz, Commander in Chief of the Pacific Fleet.

awakened America to be added to the mounting number of needed planes, with the result which we see today. An industry which counted its output in tens – or at most in hundreds – is becoming geared to produce planes by the thousands, and in the near future by the hundreds of thousands.

The tempo of American life has made the development of several of its most useful devices fantastically rapid. The automobile and the radio are two excellent examples; there are millions of both in use today throughout the country. The nationwide use of them has definitely shaped, definitely conditioned our civilization. But neither the automobile nor the radio has undergone or even contemplated the terrific expansion which war has forced upon the aircraft industry. The rapid growth of the automotive industry, however, makes possible the expansion of the airplane factories at such breathless speed. For, without the techniques, sciences, skills and organizations created and perfected by the automobile, the plane would be simply a futile dream.

Reduced to its simplest terms, any manufacturing operation is a matter of men, materials, and machines. Airplane manufacture today is employing nearly a million men. To be sure, thousands of them have had to be trained from total ignorance, total lack of any skill. But many more thousands have come to aviation trained in automobile techniques, already accustomed to shop routine, shop methods, shop requirements.

■ Automobile-Aircraft Cooperation

Most airplane plants have been traditionally located near air-ports, and most of the new ones have been built well removed from centers of population. Under normal conditions, this would have been an excellent practice, but under war restrictions it presents some troublesome problems. Transportation of the employees to and from work and housing of the employees are two of the most serious. To illustrate: suppose a factory is built 10 miles from a city; it is designed to employ a thousand men, most of whom have been living in that city and are part of it. Now, suddenly, it develops that the factory will shortly need 30,000 men. They begin to arrive in the nearby city and soon every available house is taken, long before the need is filled. Then, to complicate matters, rubber and gasoline become scarce, established workers have difficulty getting to and from the factory, and new arrivals find it an impossibility.

Obviously, dwellings must be built and transportation provided or the factory cannot operate. But, far more than dwellings are needed; what the manufacturer must plan on is the outright creation of a new community, and if his employees number 30,000 then he must plan on building a community of 100,000. A complete community, be it noted, involves all the elements of living – houses, stores, theatres, facilities, schools, churches, hospitals as well as buildings, roads, police, parks, and supplies of all kinds.

Multiply this illustration in whole or in part by one hundred, and you have a picture which exists all over the country today. It is simply a nation-wide dislocation; the people involved are not new people. They have all lived somewhere in the United States, but the homes which they have left are not properly located for the needs of war industry. Of course many other industries are also expanding, also clamoring for men, but they only add to the confusion caused by the mushroom growth of aviation.

The machines which are necessary in aircraft manufacture have themselves been a tremendous problem. Many of them are even yet experimental in design, many of them are entirely unfamiliar to the operators, and all of them, broadly speaking, are insufficient in quantity. The engineering problems connected with the machinery have been complicated and troublesome, and there are far from enough engineers to go round. Here, again, the automotive industry has been of signal help, for many of the existing machines in automobile factories can be adapted to the work of building airplanes. Such adaptations are a great challenge to the motor car plants which have been or are being converted to airplane manufacture, calling to mind Admiral King's famous instruction to his captains: "Do the best you can with what you have." And that is precisely what many manufacturers are doing today; if the specific machine needed for a certain operation is not available, they accomplish the desired result by using two or more machines which they already have. This procedure takes longer than the use of the proper machine, but it is far more rapid than waiting weeks or months for the proper one to be made. Similarly with the buildings which house the plane-builders; many of them were built for other purposes, but they can be made to serve aviation's needs – and they are!

Necessary materials present still another problem, for airplanes require many things unknown elsewhere in the war effort, in quantities unheard of in the past. Steels of varying character, non-ferrous alloys for several different purposes, plastics, copper, aluminum, magnesium – all these and many others are needed in ever-increasing amounts, to make planes suitable for the various and rigorous demands of war. Not only are the materials themselves a problem, but the processing, the forming, and the transportation of them to vital points at proper times present like difficulties.

Yes, the problems attending war-time expansion of aviation are interesting. They are also puzzling, irritating, and at times heart-breaking. But the work must go forward, and it *is* heartening to know that it is going forward.

■ Genius for Organization

The over-all problem, of course, is one of organization and here we see American industrial genius at the peak of its efficiency. That peak must be improved, but it has already achieved near-miracles. The structure of airplane manufacturing organization resembles the automobile structure of a generation ago, when most automobile manufacturing plants were really assembly plants. In that day, engines, generators, ignition systems, lighting systems, wheels, bumpers, many items indeed were made by specialized firms and assembled at the factory which bore the car's name.

So it is with planes today. Engines, propellers, accessories and airframes are four great separate industries. Moreover, in each one of these a great many items are made by subcontractors, so that any given plane really is a composite of the work of many factories. The development of this system of subcontracting is really the history of aviation expansion. It has called into play thousands of

turn to page 64

The WAR PRODUCTION EFFORT in AIRCRAFT

by T. P. WRIGHT
Deputy Director of Aircraft Production, War Production Board

THE five M's of production are Materiel, Management, Machines, Materials, and Men. Let us study each one as it relates to our aircraft program.

Materiel – I here refer to the product, the airplane itself. Accounting for the excellent fighting and performance characteristics of our planes, is the fact that in design excellence we are unexcelled. This too applies to workmanship, to accuracy in construction.

Here I would like briefly to discuss engineering changes; always undesirable production-wise, they nevertheless continue to be with us, and to a greater or less degree will always be present as a most difficult problem. Changes fall into three categories as follows:

We have what we may call *modernization changes.* These are the changes which are found necessary from the war experience abroad in order to make our aircraft acceptable and satisfactory for war service. Our fighting men must have the best. These must be incorporated. Then, we have changes made in the *interest of standardization.* There is an anomaly here in that standardization is aimed at greater production; and yet, at the time that a change is put in even though it is due to standardization, it causes delay. In fighting a global war, however, with many allies, this class of change also is necessary. The third classification of changes is the numerous *minor refinements* which, though admittedly representing improvements are nevertheless possibly unnecessary. Production and the attainment of the ideal are at opposite poles! Therefore, it can be said of any change that "if it is not necessary to make the change, it is very necessary not to make it!" But I fear, to some extent, changes will always be necessary.

Management – In an all-out war effort there are two interdependent parts to the management problem: the management within industry and the control from government. Management in industry being highly individualistic and resentful of controls, and government being suspicious and filled with honest concern for the overall problems faced,

[Excerpts from the paper presented at the "War Production of Aircraft Meeting," sponsored jointly by the Detroit Section of the Society and the Engineering Society of Detroit, with the cooperation of the SAE Aircraft and Aircraft Engine Activities, Detroit, Mich., June 8, 1942.]

have found difficulty in getting in step. The problems have been tremendous. As a government representative, sympathetic with the problems confronting industrial management, let me give a sketch of our Washington set-up as it pertains to aircraft.

Our first and controlling job is to render assistance to the military services in all matters pertaining to production. This job encompasses a large field.

As you know, there was a start made in 1940 with the National Defense Advisory Commission, a body that had no real power and did not get very far in surmounting the organizational problems involved, although a good start in setting programs and arranging for expansion was made. Early last year the OPM was formed. The Aircraft Branch took over many of the personnel from the old National Defense Advisory Commission. Then this year came the WPB. Fortunately, our Aircraft Branch changed little with these reorganizations.

The board of directors for all of our aircraft activity in Washington is the Joint Aircraft Committee. This Committee is composed of eight men: two representing the Army Air Forces; two, the Navy Bureau of Aeronautics; two, the British Air Commission; and two, the Aircraft Branch of WPB. This Committee has jurisdiction over all matters pertaining to the allocation and standardization of aircraft in the war production program. It is a Committee that, it seems to me, acts more wisely and more diligently than most boards of directors in civilian life. We have been meeting regularly every week, with full Committee representation, for over a year and a half. I think that we, in aircraft, have set a pattern and a high standard in this regard for the other defense branches to follow. Our standardization work is handled by a working subcommittee. In this group we determine, with the approval of the military services, the items derived from British war experience which should be incorporated in our planes. Also, we standardize the equipment built in a given factory from which the output is going to two or more services, thus greatly facilitating production.

In the matter of allocations, the programs which are established by the Air Forces or the Navy, or by the Defense Aid organization, are formed into an approved schedule of deliveries for the industry to follow. These schedules are the basis for the allocation of materials and equipment.

Within the Aircraft Branch of the WPB there are several sections. One is the Program Planning Section. It has charge of preparing in detail the schedules based on approved programs, and includes airframes, engines, and propellers. Another group analyzes the past output so as to develop the parameters on which production capacity estimates can be based.

Another section deals with materials, and another with accessories and equipment.

Then we have a Priorities Section. Formerly, priorities of all branches of the defense effort were handled in one Priorities Division. Very wisely, some time ago, this authority was delegated to the various branches dealing with a particular end product, so that now we handle our own priorities on an allocation basis supplemented by preference ratings.

Another group of our Aircraft Branch is the Manufacturing Section which deals with tools, facilities, and other manufacturing problems. It has men in the field visiting the aircraft and subcontracting factories with the view to ascertaining and assisting in correcting difficulties. It assists in determining the need for new facilities and the best manner of getting them.

In addition to these sections, we have project expediters who deal with the airplane itself. In this group are specialists concerned with particular types of airplanes; or parts of the airplane such as the propeller, turrets, oleo struts, superchargers, and so on; or those who deal with the coordination of standardization matters. These men serve more or less in the capacity of project engineers. They are trouble shooters and expediters. They also deal with engineering problems when they arise, although the WPB has no definite engineering responsibilities, these being assumed by the technical branches of the military services.

Finally, there is the Aircraft Scheduling Unit located in Dayton, O., whose job is to schedule materials and equipment in detail to the industry and to survey the industrial capacity to produce. The balance between capacity and requirements is a measure of the expansion necessary. This Scheduling Unit consists of one representative from the Army Air Forces, one from the Navy, one from the British, and one, the Administrator, from the WPB. This unit settles policy matters, the details of which are carried out by the Industrial Planning Section of the Materiel Center, Army Air Forces.

In our Branch we have made a number of important studies and have written reports covering them. Those dealing with requirements of basic materials have served as a basis for determining necessary expansion. Also, we have determined probable deliveries of aircraft and we are quite proud of the fact that, in general, our schedules have coincided with the actual deliveries of almost all of the companies extremely closely. We have made other studies of the time required for experimental development. We have found that first estimates of the length of time to develop a new type of airplane are usually optimistic; it always takes longer than the prediction. This is important to know in planning long-range programs. On the other hand, production deliveries, once really under way, frequently exceed expectations.

In general, it can be seen from the foregoing that the Aircraft Branch, WPB, is the link between pre-war government agencies, such as the Army and Navy, and industry. It also frequently performs the function of referee between the services where conflict exists. The outstanding success of the industry in meeting the severe schedules established is a credit to the manufacturers and an indication of satisfactory collaboration between government and industry.

Machines – This is the machine age which connotes the importance of machine tools in our war production effort. A measure of degree of expansion of the tool industry is shown from the dollar value output: in 1940, 400 million dollars; 1941, 800 million; and, estimated in 1942, one billion dollars. Tools were a definite bottleneck in 1941 and will continue "tight" in 1942, although less noticeably so because of the vast expansion already accomplished.

Materials – There were few critical materials in 1941, whereas today many items are appearing on the list. However, there have been few important losses in numbers of planes delivered due to material shortages and none is anticipated in the future due to lack of those basic materials for aircraft, aluminum and magnesium. We are short of some fabricating equipment for these materials,

deficiencies which will be overcome. However, to provide our ever-increasing output with materials, there must be a severe curtailment in civilian uses for many critical material items such as rubber, nickel, tin, and other alloying elements, during 1942, and universal sacrifice in 1943. Let us see that there are no special privileges in this rationing process.

Men – There was no shortage of labor in 1941 and, because of excellent training programs then started, there will be no very severe shortages in 1942 with, however, exceptions in some localities. Eventually, however, the limitation to expansion will be availability of men, a deficiency which will be met by introduction of women into the aircraft industry, a process now well under way. Last October the percentage of female workers to the total was but 1% in the airframe industry, with a negligible number in engines and propellers. Now, the percentages are 9 for airframes, 5 for engines, and 3 for propellers, with some companies in those categories employing 25%, 15%, and 5%, respectively. We may expect to see the figures eventually go to 40%, 20% and 10% on the average in airframe, engine, and propeller plants.

Hours of work per week now average about 50 for each employee, with plant utilization (measured by total man hours divided by number of workers on the first shift) approximately 110 hr for engines and propellers and 88 for airframes. These utilization figures will increase as unbalanced material conditions are overcome, but it is expected that the average work week is now quite properly stabilized.

Regarding labor relations, credit for improved conditions since Pearl Harbor should be given largely to our American workers themselves, not, I regret to say, to their own leaders or leadership furnished by the government. I think they sense that this war is, as Vice-President Wallace so aptly put it, "a revolution of the common people," and that it is "a fight between a slave world and a free world!"

In concluding this discussion of fundamental production factors, I would like to call attention to the changing emphasis which we must give. Roughly, our 1941 problems were concerned with tools; in 1942, they were concerned with materials, and 1943 will be concerned with materials and labor. Again, from our Aircraft Branch, WPB, standpoint, 1940-41 was a planning period; 1941-42, a facilities period; and 1942-43 will be a production period.

Special Production Problems

Inefficiencies in the Democratic Process – The fundamental concept of our governmental organization makes inefficiency to some extent inevitable. This concept of checks and balances results in a multiplicity of overlapping agencies and in the need to process papers through many departments, each having a veto power but none having decisive authority to force action. Programs must be made out in detail, then presented to the Bureau of the Budget, and then to the Congress to obtain funds. Then innumerable agencies must get into action to furnish their approval or comment based on such studies as appears appropriate.

But although efficiency is one of the measures of a government's virtue, we must not imply that it is the chief measure, as many people seem to believe. The things a government does not do are often as much a virtue as the things it does. Economic efficiency in terms of war is economic inefficiency in terms of public welfare, and we are fundamentally a peace-loving people, not a people to goose-step meekly to orders. In the hurly-burly of work and criticism we must never forget what we are fighting for and be tolerant of such delays as are inevitable in our democratic process so long as it is apparent that rectifying measures are undar way, as they usually are.

Bottlenecks – Of course, our chief bottleneck was time to get started. Lost time cannot be bought back. And yet it takes time to develop new designs, to cure initial ailments, to tool up for production, and to "get them rolling." Those of us acquainted with engineering and production problems are more tolerant (though, I can assure you, still impatient) of time consumed in these operations both in government and in industry. In this regard there is a statement of Gen. Knudsen's which I would like to quote. When he was criticized for the length of time it seemed to take in getting things going – he said: "You see, gentlemen, it's like this. Despite modern hospitals and anesthetics, despite your obstetricians and psychiatrists, despite all your advancements in research, medicine, and science – it still takes nine months!"

Problem of Unbalance – Fundamental among the problems that confronted us from the outset has been the existence of unbalance – the task of obtaining balanced flow of all components of the finished airplane. It will be recognized that, when a new program is received by the Aircraft Branch, WPB, from the services, such program is presented in terms of airplanes. A specific model and manufacturer are indicated so that any necessary expansion of the airplane builder can be undertaken almost at once. However, such a program in so far as materials and equipment are concerned will include similar parts and items required for each of many airplane types, and the total is obtainable only by making a complete cross-check analysis of the specifications of these basic airplane types. This analysis is started at once, either by the appropriate section of WPB Aircraft Branch in Washington or by the Scheduling Unit in Dayton. Completion of the many analyses will yield the total new requirements for materials and equipment added by the new programs. The total of these added to already existing requirements is then checked against a survey of the capacity of the supplying firms for each class of item to determine expansion needs. An inevitable lapse of time is involved in performing these operations so that the expansion of these many items which in the production line are required at an early stage can be undertaken only considerably after that of the airplane companies themselves.

Coupled to the aforementioned difficulty is the further one that, at the outset of the war production effort, the supplying companies producing equipment, engines, and propellers were nearer to their capacities than were the airframe companies. This meant that the airframe companies could absorb additional work without expansion to a greater extent than could the others.

On top of the foregoing is the added time-consuming factor that the extent of machine tools and therefore the amount of time necessary for expansion is far greater for plants building equipment, propellers, and engines, or those producing materials, than for those producing airframes.

The partial solution of the resulting problem of un-

turn to page 64

ARMY-

AERONAUTICAL

The Record

by COL. D. G. LINGLE, A.C.

Army Member, Working Committee of The Aeronautical Board

Col. D. G. Lingle, A.C.

IN providing in a single paper a clear and complete record of the history, organization, procedures, and operation of Army-Navy Aeronautical Standardization, Col. Lingle and Capt. Seitz, Army and Navy Members, respectively, of the Working Committee of the Aeronautical Board, satisfy a long-felt need.

They trace the fifteen-year development of Army-Navy Aeronautical Standardization, and explain by text and chart the organization, functions, and operation of the Aeronautical Board, the Working Committee of the Board, the Army and Navy Specification Units, the ANC Committee on Aircraft Design Criteria, and the Joint Aircraft Committee, showing their relationship

ARMY-NAVY aeronautical standardization would probably receive a great deal more publicity if it didn't exist. This statement may sound paradoxical but the same applies to other important phases of airplane production which never make the front page, simply because they're not trouble spots. We hear a lot about materials shortages, lack of fire-power, mass-production pains, and want of this and that. But the papers say little, for instance, of our aircraft structural design methods, our intricate heat-treating and welding processes, or our excellent inspection systems. One feature is as important as another in the whole production process but, when the job is being done, no one talks about it. And so it is with AN standardization. There are now over 300 ANA specifications and 400 ANA drawings in effect, and a strong program is under way to increase this number manyfold. These AN standards are serving their purpose and, consequently, are not spot news material.

Army-Navy standardization of aeronautical materials and equipment, of course, is not something new. It has been in effect in increasing degree for about fifteen years. Back in the days of Keystone bombers and Conqueror engines the Army Air Corps and the Bureau of Aeronautics, with the Naval Aircraft Factory, realized that, whereas there were two separate air services, there was only one aeronautical industry, and this industry should not be required to work to two different sets of requirements. The task that faced them was enormous, but they began on the sound principle of first standardizing the small parts and basic materials as prerequisites to the larger and more complicated items of equipment. Annual AN standards conferences were held and "AN master" specifications and drawings prepared. In due time, all the bolts, nuts, cotter-pins, washers, rivets, tie-rod terminals, clevis pins, turnbuckles, and so on, and larger items of equipment as well, were made "AN" standard. AN Standard drawings for these parts became familiar to all aeronautical draftsmen, and parts manufacturers featured the symbol "AN" in their catalogs. The SAE handbook devoted a section to aeronautical standards and referenced their "AN" identity. The process of Army-Navy standardization continued through the early 1930's but was not strenuously pushed. The system used at that time was to prepare a "master" copy of the AN specification or drawing; to obtain signatures of Army and Navy representatives; and then to use this "AN master" document as the common basis for the preparation of separate Navy and Army procurement docu-

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-NAVY STANDARDIZATION

So Far

and CAPT. G. A. SEITZ, U.S.N.

Navy Member, Working Committee of The Aeronautical Board

to the CAA, the SAE Aeronautics Division, the National Aircraft Standards Committee, the Engine and Airplane Technical Committees of the ACC, the Society of Aeronautical Weight Engineers, and other commercial standardizing agencies.

The operating procedure in the development of AN standards, bulletins, and indexes, is explained by following through specific examples from their conception to their adoption and promulgation to the industry and services.

This lucid, complete and authoritative paper promises to serve as a bible for thousands of aeronautical and automotive engineers.

Capt. G. A. Seitz, U.S.N.

ments. This procedure was based on the reasonable theory that two specifications equal to the same specification would be equal to each other. However, circumstances repeatedly arose wherein it was expedient for the Army or Navy to revise its own specification without waiting for agreement of the other service and, as a result, the actual procurement requirements became non-standard. There was no separate office established in either service for the exclusive purpose of standardization, and the work was carried on as an extra assignment by personnel with other duties. In 1937, however, the subject was brought to the personal attention of the Chief of the Army Air Forces and the Chief of the Bureau of Aeronautics, who quickly recognized the need for greater emphasis on this work. The case was taken up by the Aeronautical Board which, after review of the circumstances, directed that procedures and facilities be established to increase the scope of AN standardization and assure its positive effectiveness. The means adopted for this purpose consisted of placing control of all AN standardization activities directly under the supervision of the Aeronautical Board. This is the point at which Army-Navy aeronautical standardization entered its current phase. It may be well at this time to explain the organization of the Aeronautical Board and its Working Committee.

■ The Aeronautical Board

The Aeronautical Board was originally created as the "Joint Army and Navy Board on Aeronautic Cognizance" pursuant to a proposal by the Secretary of War in October, 1916. The name was changed in 1919 to "Joint Army-Navy Board on Aeronautics" and the Board was directed by the Secretaries of the War and Navy Departments to study a policy for the development of aeronautics. To avoid confusion, the name was later changed to "The Aeronautical Board." The Board was reorganized and its functions clarified in an order signed by both Secretaries in 1924. Effective July 1, 1939, a military order signed by the President as Commander-in-Chief directed that the Aeronautical Board – organized for the purpose of securing a more complete measure of cooperation and coordination in the development of aviation of the Army and of the Navy and to provide an agency for the consideration

turn to page 66 ▶

Upsurge in T&M War Work Unfolded at NY Meeting

SAE-ODT data revealed as insurance for war maintenance of US vehicle transport

IMPORTANT parts of the war maintenance data being developed by SAE T&M committees for the Office of Defense Transportation were revealed officially and impending services on Army maintenance problems for the Ordnance Department were informally discussed during the stirring SAE War Transportation and Maintenance Meeting at the Hotel Pennsylvania, New York City, Oct. 7 and 8. More than 500 members and guests attended. (The Summer Meeting having been cancelled, this meeting was officially designated as the Semi-Annual Meeting of the Society.)

Led by ODT Maintenance Section Chief William J. Cumming – who is also chairman of the SAE-T&M Coordinating Committee under whose auspices 30 separate ODT-assigned projects are going forward – and SAE-T&M Vice-President Jean Y. Ray, prominent SAE committeemen detailed practical data already completed on expander-type piston rings to prevent excessive wear, on standardization of instruction sheets for use by working mechanics, and on applications and technique of metal coating in maintenance operations.

These finished reports – typical of scores of others already on their way to completion by the SAE-T&M war maintenance committees – revealed clearly the practical character of the work now being accomplished and the vital part that such information is to play in helping the ODT to insure proper maintenance of America's war-needed transportation system.

Design factors affecting maintenance came in for discussion as well as repair and conservation methods. Particularly were design phases emphasized when Mr. Cumming voiced his belief that "the mechanical puzzles now presented by modern design will have to give way to something that takes less time to solve . . . I know of no fleet operator," he said, "who is in a position to pay mechanics to try to outguess the designer when he hid the available means of making adjustments and repairs. . . . The man who uses and cares for trucks and buses has suddenly become important," Mr. Cumming declared. "It took a war to make him so, but nevertheless he has arrived."

Brig.-Gen. Kirk at Dinner

Nearly 300 attended the dinner meeting on Wednesday evening, at which SAE-T&M Vice-President Jean Y. Ray was toastmaster. Herbert Happersberg, SAE Metropolitan Section Chairman, opened the dinner session and introduced Vice-President Ray. Brig.-Gen. James Kirk, chief of the Maintenance Branch, Field Service Division, Office of the Chief of Ordnance, was among the distinguished guests at the speakers' table.

Asked to speak extemporaneously, Gen. Kirk said that we in the United States are right now in transition from a production war to a fighting war. Maintenance becomes increasingly acute, he indicated, as that transition goes on. Difficulties are various. Untrained men are prone to neglect their vehicles through ignorance, he said, while provision of adequate parts supply gets tougher as it becomes necessary to transport vehicles all over the world. Under these circumstances the need for interchangeable subassemblies becomes increasingly desirable. We must consider all types of parts and subassemblies from the combat point of view. We must decide on kinds of equipment which can be best transported, handled, and used in battle. He mentioned, too, the need for simplification of the variety of lubricants as another maintenance factor of current military interest.

Throughout the military maintenance field, proper mating of armament and automotive is essential, Gen. Kirk emphasized. A truck, for example, cannot be visualized as something which runs around and carries a load; it must be visualized and built as a platform upon which to mount a weapon. Where that viewpoint is lacking in design, he emphasized, maintenance becomes particularly hard. Maintenance crews must be competent, he added, to repair not only the motor vehicle, but also the guns and weapons which are mounted on it.

Prior to the speaking program on this occasion, SAE President A. W. Herrington called to order the semi-annual business meeting of the Society. The proposed constitutional amendment to change the name of the Society to "The Society of Automotive and Aeronautical Engineers, Inc." was brought before this business meeting of the Society for its second reading, and upon motion duly seconded was tabled for further consideration until the 1943 Annual Meeting. The semi-annual business meeting was then adjourned.

President Herrington Chief Speaker

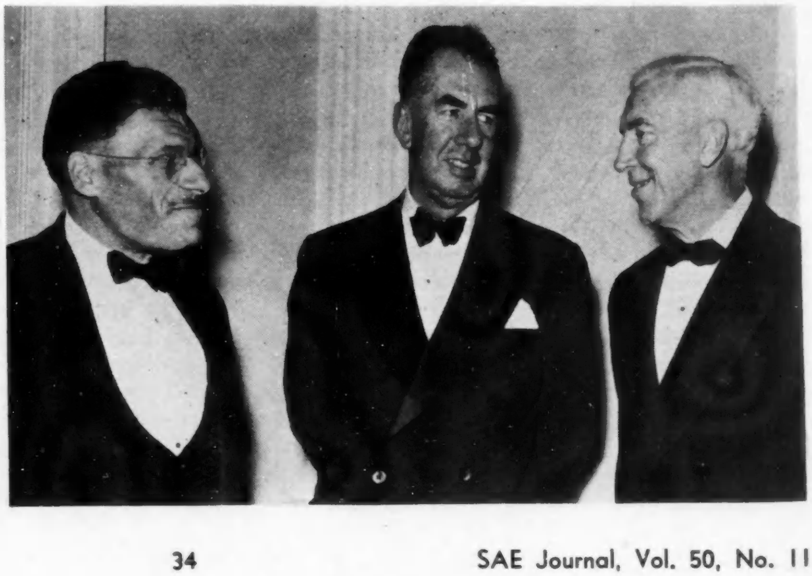
"The United States must take its place as the leading military power in the world if peace is to be preserved after this war," President Herrington declared in his address which comprised the main feature of this dinner session.

Five years from now, he predicted, our geographical position will no longer – and never again – be a protection to us. Aircraft development will have changed the picture of the past entirely – and that change already is well on its way to completion. Airborne transport, he pointed out, has increased 5000% in the last year. From now on, he emphasized, the United States must be ready to meet any attack from any angle.

Mr. Herrington reemphasized in this talk the high quality and performance of American aircraft, a subject which he had stressed strongly a few days previously at the SAE National Aircraft Production Meeting in Los Angeles – a report of which appears on other pages of this issue.

"The duly qualified military air representatives of our military service and of our allies see eye to eye," he declared, "on all questions of the relative performance of aircraft. By parallel tests, a true comparison of the performance of every type is known and recorded. There is a considerable discrepancy between the catalog and trade paper claims of the performance of airplanes and their total actual performance under military load and combat conditions."

Studded with specific incidents of great interest were those parts of Mr. Herrington's talk which dealt with his trip to Africa, India, and China early this year as a member of an important government mission. Out of these experiences, Mr. Herrington said, one thing stands out in his mind: "I wish I had as much confidence in the ability of those of us on the home front to do the job ahead of us as I have in those grand fellows out there who are taking an awful punching around every day while we are trying to straighten out our thinking here and find out what we are up against. Out



Major rôles at the Annual T&M Meeting were played by Austin Wolf (left), general chairman, SAE President A. W. Herrington (center) and W. J. Cumming, chief, Maintenance Section, Motor Transport Division, Office of Defense Transportation, a speaker.

SAE Vice President Jean Y. Ray talks with two distinguished guests at the Annual T&M dinner, Oct. 7, in New York. Brig.-Gen. James Kirk, chief, Maintenance Branch, Field Service Division, Office of the Chief of Ordnance (center) and Col. T. L. Preble, who is now on the General's staff, were among the honored guests.

there they know – they are learning the hard way."

Flaying small-minded men who put selfish interest above our nation's needs in these perilous times, Mr. Herrington pointed to storm clouds on the horizon which, he said, are formed by the wrath of the American people. "When the storm breaks," he concluded, "it will sweep aside the shallow thinkers who have been hindering our war effort. It will be a storm which will burst the limits of all political boundaries. It will recapture for us something of the spirit of that pitiful little army of 2400 real Americans who straggled down to McKonkeys Ferry on Christmas Day, 1776 and, tramping into Trenton, laid the foundations for this wonderful country which is ours to have and to hold as long as we are willing to fight for it."

Highway To Victory – WILLIAM J. CUMMING, Chief, Vehicle Maintenance Section, Division of Motor Transport, Office of Defense Transportation

WITH metallurgists, designers, and production devoted solely to the war effort, maintenance engineers are left on their own; the result after the war will be a new high in efficiency, Mr. Cumming believes.

As a result of our lack of replacements, trucks and buses are being operated many more miles than the designers expected of them. We have had to find out, from sheer necessity, what parts failed us, and with what frequency. This knowledge will make us better buyers of equipment than we ever were before, he pointed out.

"Of one thing you may be sure," Mr. Cumming declared. "After we have operated the vehicles for many more miles than we had been led to believe was in them, you can rest assured we will never be satisfied to go back to the shortlived vehicle.

"America's existing highway transportation plant must be properly maintained and to that end Mr. Rogers (Director, ODT Division of Motor Transport) set up a Vehicle Maintenance Section in the Division of Motor Transport to develop a program to assist in this endeavor," Mr. Cumming revealed. The Parts Availability and Supply item is one of the most important functions of the Maintenance Section. The knowledge of how automotive parts of every type are manufactured provides the basis for procedures that may be set up to reclaim parts when they are worn. Of great value, too, are processes practiced by fleet operators for years in conserving worn materials. In this time of shortages in important metals this knowledge is of great value.

ODT Maintenance Section personnel feels that the word "salvage" in connection with conservation does not properly describe these processes because salvage suggests scrap piles, when actually most worn materials are far removed from the junk classifications, Mr. Cumming explained.

In explaining the conservation program, Mr. Cumming pointed out that it is necessary to determine the availability of replacement parts at or in parts manufacturers' supply stocks; jobber-dealer stocks; and vehicle manufacturers' stocks. Second, a survey of parts needed by vehicle operators must be made in order to determine their comparative need in value and volume in relation to the present supply. The next step is to gather information as to future potential need of replacement parts (based on inability to obtain new replacement vehicles); and then present and future sources must be analyzed, bearing in mind present sources, government military orders which may reduce ability to produce parts, enlargement of present sources, re-creation of inadequate sources, and the creation of new sources.

The author feels that with these situations determined, measures can be taken in cooperation with other government bodies to design means whereby the possibilities of shortages can be anticipated.

In discussing the two-fold problem of the Office of Defense Transportation, Mr. Cumming said that its first task is to improve the knowledge and ability of the maintenance man who uses and cares for trucks and buses, and who has suddenly acquired an important position since the advent of war; and second, to educate management on the difference between use and abuse.

Discussion

Training truck and bus drivers is an important factor in the proper maintenance of a fleet, J. Willard Lord, Atlantic Refining Co., declared. A driver should know more than just how to get his car through traffic. He should be taught the conservation of his vehicle – caring for tires, brakes – and he should be weaned from the habit of abrupt starting and stopping. Thoroughly in accord with this plan was V. J. Lowenstein, Carter Carburetor Co., who explained that his company has been training men in the handling and maintenance of a vehicle. His company found that there is an appalling number of men in the maintenance field who have no maintenance background. They stem from all walks of life and all types of work. A training system should be installed here too, he believes.

The day when the executive had the say and the maintenance man – who actually did the work and was so much closer to the problems – followed out these orders, is over. The war has made the importance of the maintenance man felt, and we will be getting two, three, and five times as much mileage because of competent maintenance procedures. These are beliefs voiced by T. D. Pratt, N. Y. State Motor Truck Association, Inc., New York City.

Many causes for the short life of a vehicle were brought to light. Austin Wolf, consultant with the Motor Transport Division, Ordnance Department, listed overloading as one of the main factors shortening the life of a vehicle. M. E. Nuttila, Cities Service Oil Co., suggested the elimination of unnecessary traffic lights to reduce the harmful results of start and stop. W. F. Benning, Mack Mfg. Co., mentioned the "standsit seats," another overloading agent.

Appreciation for the help of Mr. Cumming's ODT Maintenance Section was expressed by Ervin N. Hatch, American Brakeblok Div., New York City; and Joseph A. Harvey, Pittsburgh Motor Coach Co., Pittsburgh. Mr. Harvey complained, however, about the difficulties confronting the buyer of materials for repair. Warren A. Taussig, Burlington Transportation Co., Chicago, agreed with Mr. Harvey about the seriousness of this situation.

C. S. Rodine, Automotive Branch, War Production Board, and Mr. Cumming jointly explained that the ODT helps in locating materials when requested, but that it is in no position to reach out and place needed parts and materials in the hands of the man who needs them. Many times the fault lies in the hands of the parts purchaser, they pointed out. Because he can't get the needed part from the usual source, he takes it for granted that there is none to be had and he looks no further.

WPB investigations have brought to light the bad distribution of parts and materials, and it is up to the man who needs the parts to search diligently, Mr. Rodine said. He told of a plan of the Automotive Branch to place representatives in the field to assist in individual problems. This plan will be in effect within three weeks or a month.

The Use of Expander-Type Rings to Prevent Excessive Cylinder Reconditioning – P. E. FRIEND, Wilkening Mfg. Co.

(Based on the findings of the SAE-ODT Committee No. 5 in the laboratory and in the field.)

"NO longer do engine manufacturers frown on the use of expander-type rings as a questionable procedure," Mr.

turn to page 57

Registration clerks were kept busy issuing badges to the more than 1600 who registered for admission to the meeting.

U. S. Aircraft Superiority Stressed in NAPM Talks

War technical data exchanged at SAE National Aircraft Production Meeting. 13 papers given

AIRCRAFT of the United States' Armed Forces are superior, type for type, to those of the air forces of Allied Nations' enemies, and these superior U. S. planes are being steadily and speedily improved. Their production is leaping sharply, and new models are arriving at the numerous fronts of the world's first global war in rapidly increasing and gratifying numbers. Their weight is being felt by the enemy, and they have already tipped the balance of air supremacy to the Allied Nations' side on all but one minor and one major front. Such is the current picture of U. S. military aircraft, as unfolded at the SAE National Aircraft Production Meeting, held in Los Angeles' Biltmore Hotel, Oct. 1, 2, and 3, and summarized by SAE President A. W. Herrington in his address to a record-shattering, standing-room-only audience which attended the Friday night session.

Arthur E. Raymond, vice president in charge of engineering, Douglas Aircraft Co., was general chairman of the entire meeting. Members of the Southern California Section acted as a reception committee and cooperated actively in completing the arrangements which made the meeting an outstanding success.

President Herrington's summation came at the logical climax to eight conference sessions which heard 13 papers on technological progress, and three speeches which were authoritative, eye-witness reports on the performance of U. S. aircraft in action on and behind the fighting fronts. Although two of the eight sessions, one of the eye-witness reports, and two of the 13 papers followed the SAE President's summary, they in no way contradicted the theme of his speech and did much to confirm it.

Before the enthusiasm precipitated by his statements, indicated by prolonged applause, had time to subside it was fanned to new heights by his announcement that an aircraft man has been nominated to be president of the SAE for 1943. He is Mac Short, vice president in charge of engineering, Vega Aircraft Corp. of Burbank, Calif. Mr. Short was presented to the audience by President Herrington.

Praises SAE Standards

Another highlight of the Friday night session, which brought enthusiastic response from the audience, was a talk by Col. J. H. Jouett, President of the Aeronautical Chamber of Commerce of America, Inc. Col. Jouett contradicted recently published statements, which he termed misinformed and detrimental to public morale, that U. S. aircraft are inferior to those of Germany and Japan, and gave data to prove his point. He said we also have every reason for confidence in our military leaders as they have already demonstrated their foresight and ability by the swift manner in which they have deployed our forces at strategic bases throughout the world. The box scores of these widely scattered bases, and especially of the air forces operating from them, are overwhelmingly conclusive proof of the excellence of the personnel and the high performance and stamina of the aircraft with which they are equipped.

Col. Jouett especially lauded the SAE for its work on standardization in the aircraft industry. He attributed much of the success of U. S. planes to the fact that standardization has contributed heavily to keeping them in fighting shape under unbelievably adverse servicing conditions.

At this same session, Tye M. Lett, Jr., Allison Division, General Motors Corp., gave a graphic account of the feats of servicing performed by ground crews of the American Volunteer Group in China in 1941-42. Thomas Wolfe, representing the Air Transport Association of America and speaking for its president, E. T. Gorrell, who was

The turnout for the annual President's Dinner filled all seats at the horseshoe-shaped table. On outside of left table, front to rear, are: J. F. Cramer, Boeing Airplane Co., J. B. Wassall, Vega Aircraft Corp., S. K. Hoffman, Aviation Corp., Lycoming Div., Eddie Molloy, Ryan Aeronautical Co., J. D. Redding, SAE, Harry Woodhead, Consolidated Aircraft Corp., Arthur Nutt, Wright Aeronautical Corp. C. T. Torresen, North American Aviation, Inc., was first on left side but just out of camera range.
At head table, left to right, are: A. E. Raymond, Douglas Aircraft Co., Inc., A. T. Colwell, Thompson Products, Inc., SAE past president, Col. John H. Jouett, Aeronautical Chamber of Commerce of America, Inc., SAE President A. W. Herrington, Thomas Wolfe, Western Air Lines, and Mac Short, Vega Aircraft Corp., SAE presidential nominee for 1943.
On outside of right table, front to rear, are: Earl D. Prudden, Ryan Aeronautical Co., T. Claude Ryan, Ryan Aeronautical Co., Rex M. Cleveland, "New York Times," Peter Altman, Vultee Aircraft, Inc., C. F. Bachle, Continental Aviation & Engineering Corp., Robert Insley, Kinner Motors, Inc., R. R. Teetor, Perfect Circle Co., and T. M. Lett, Jr., Allison Div., General Motors.
At inside of left table, front to rear, are: R. H. Rice, North American Aviation, Inc., J. T. Gray, Aeronautical Chamber of Commerce of America, Inc., C. P. Sander, Kinner Motors, Inc., E. F. Lowe, SAE, Los Angeles, E. H. Heinemann, Douglas Aircraft Co., Inc., R. M. Hazen, Allison Div., General Motors Corp., and L. T. Cohu, Northrop Aircraft, Inc.
At inside of right table, front to rear, are: John A. C. Warner, SAE General Manager, C. J. Abbott, Jacobs Aircraft Engine Co., Allen Guiberson, Guiberson Diesel Engine Co., H. D. Hoekstra, Civil Aeronautics Administration, S. A. Bell, Hughes Aircraft Co., E. F. Burton, Douglas Aircraft Co., Inc., and C. E. Stryker, chairman, Aeronautical Standards Coordination Group, WPB.

unable to attend, likewise confirmed the excellence and standardization statements in a brief outline of the vital war work being done by members of that association. He predicted that the U. S. will play a major part in creating a new conception of the world after the war, by establishing a world-wide air transport system far greater than any ever previously conceived. It would offer, he said, a continuing challenge to the aircraft industry to supply the planes it will need.

The Friday night general session, high point of the three-day meeting, was welded together and kept rolling smoothly by its chairman, A. T. Colwell, Vice President, Thompson Aircraft Products Co., Inc., who opened the session with a brief statement in which he deplored the current public hue and cry about U. S. aircraft being inferior to those of the Japs. He said that the only noteworthy accomplishment displayed by the Jap aircraft industry to date is the ability to make a photostatic copy of good planes, engines and accessories developed by others. His audience of over 400 indicated its understanding of his contention.

AIRCRAFT-ENGINE SESSION
R. N. DuBois, *Chairman*

The first session of the three-day meeting was opened by Southern California Section Chairman Foster M. Gruber, Douglas Aircraft Co., Inc., who introduced A. E. Raymond, also of Douglas Aircraft Co., general chairman of the meeting. Mr. Raymond, after a very brief statement of welcome, introduced Session Chairman R. N. DuBois, Aircraft Division, Packard Motor Car Co., who read an announcement requested by the United States Government, that no discussions would follow reading of papers.

For military secrecy reasons, the paper on Automatic Engine Power Controls, by John Dolza, Allison Division, General Motors Corp., was cancelled. In its place was a paper by J. E. Ellor of the British Air Commission, on "Principles of Pressure Cooling." Because Mr. Ellor was unable to attend the meeting, his paper was read by Chairman DuBois. This paper has not yet been released for publication.

Requirements for Carburetor Air Filters for Aircraft Engines – WAYNE D. CANNON, Wright Aeronautical Corp.

MR. CANNON'S paper was built around a series of slides which included photographs of what he termed an only partially successful carburetor air intake filter used on the German Messerschmitt 109, one of which has undergone thorough study in this country, and of a crude filter installation on American made aircraft, in the field by British ground crews.

He reviewed the development of carburetor air filter installations in aircraft powerplants prior to the war, with an analysis of new problems which led to a reappraisal of filter requirements.

A description of an improvised air scoop and filter was given to emphasize the fact that the installation design of carburetor air filters is properly the responsibility of the aircraft manufacturer.

Current design requirements for carburetor air filters were presented with diagrammatic sketches of typical installations, to illustrate a number of ways of effectively reducing these requirements to practice without adding to the responsibilities or duties of the pilot.

At the conclusion of Mr. Cannon's paper a sound film, produced by the Wright Aeronautical Corp. on "Detonating," was shown and, while obviously aimed primarily at pilots, presented the causes of this highly undesirable condition in animated sketch form that was entertaining as well as informative.

FLIGHT-TESTING SESSION
C. L. Johnson, *Chairman*

Mr. C. L. Johnson, Lockheed Aircraft Corp., substituted for Mr. Lon Storey, Jr., of the same company, as chairman when the latter was unable to be present. More than 200 packed the conference room and overflowed into the adjoining hall to hear two papers, both of which held the audience and added materially to the ever-increasing fund of data needed by modern aircraft engineering.

Flight Testing Equipment for Large Aircraft – W. T. DICKINSON, Douglas Aircraft Co.

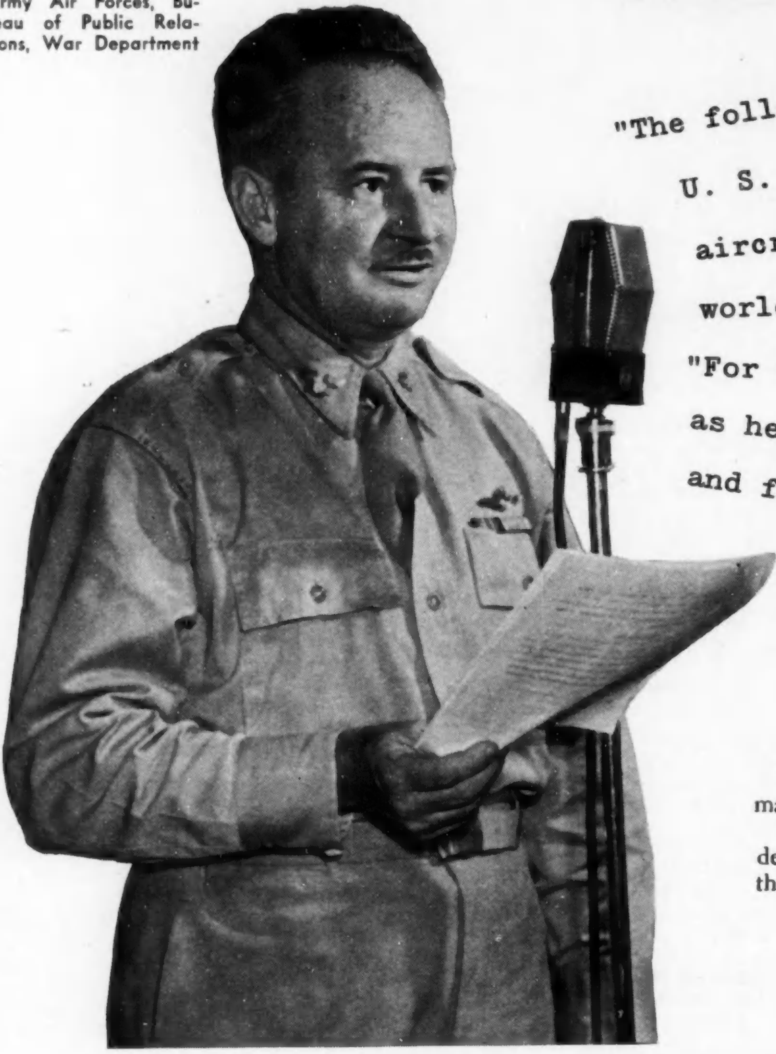
FLIGHT testing of large aircraft is no longer an heroic adventure by a daredevil pilot, as is so often depicted in the movies, in fiction, and in the biographies of flyers, but instead is now a science, the working tools of which are delicate, heavy, and expensive, automatic machines, Mr. Dickinson declared. For a typical test, that of the C-54 transport, for example, Mr. Dickinson listed instruments and equipment costing $38,600 and weighing 10,804 lb. as constituting the laboratory carried aloft on test flights. To watch and operate this equipment, crews of 12 to 22 men were required. Equipment included 2 automatic potentiometers, 2 oscillographs, camera test instrument panels, generator test panel, trailing bomb, heat and vent panel and controls, weighing 2101 lb. Interior furnishings included wood flooring, asbestos sheet, ballast boxes and hold-down covers, seats, safety belts, tables, floor angles, bracing, etc., weighing 4139 lb. Wiring and tubing totaled 12,000 ft of thermocouple wire, 4000 ft of strain gage wire, 6000 ft of general wiring, 8000 ft of copper tubing, 1000 ft of steel hydraulic tubing, and 2000 ft of electrical cable, etc., totaling 2395 lb. And 11 test batteries, generator load bank, lights, junction boxes, fuse panels, inverters, etc., weighing 2165 lb. After describing the several instruments and their functions, he predicted further developments along three directions: (1) greater instrument accuracy, (2) durability and reliability of measuring machines, and (3) increased recording speeds without loss of accuracy, durabil-

turn to page 60

Arthur E. Raymond, general chairman of the SAE Aircraft Production Meeting, Oct. 1 to 3, Los Angeles. He is vice president in charge of engineering, Douglas Aircraft Co.

Speakers and chairman of the General Meeting held on Friday night, Oct. 2, in the ballroom of the Biltmore Hotel in Los Angeles. Reading from left to right they are: Tye M. Lett, Jr., Allison Div. General Motors Corp., Col. J. H. Jouett, Aeronautical Chamber of Commerce of America, Inc., A. T. Colwell, Thompson Products, Inc., chairman of the session, President Herrington of SAE, Mac Short, 1943 SAE presidential nominee and vice president of Vega Aircraft Corp., and Thomas Wolfe, Western Air Lines, Inc.

Col. Arthur I. Ennis, Assistant Director for Army Air Forces, Bureau of Public Relations, War Department



Colonel Ennis *speaking:*

"The following pages highlight* U. S. Army Air Force military aircraft fighting today on world battlefronts.

"For convenience they are grouped as heavy, medium and light bombers, and fighters. Each has been designed for a particular type of tactical mission."

* "Space limitations prevent a showing of all makes and types.

"We would like to tell about some of the new developments, but must hold these as secret until they're turned loose on the Axis."

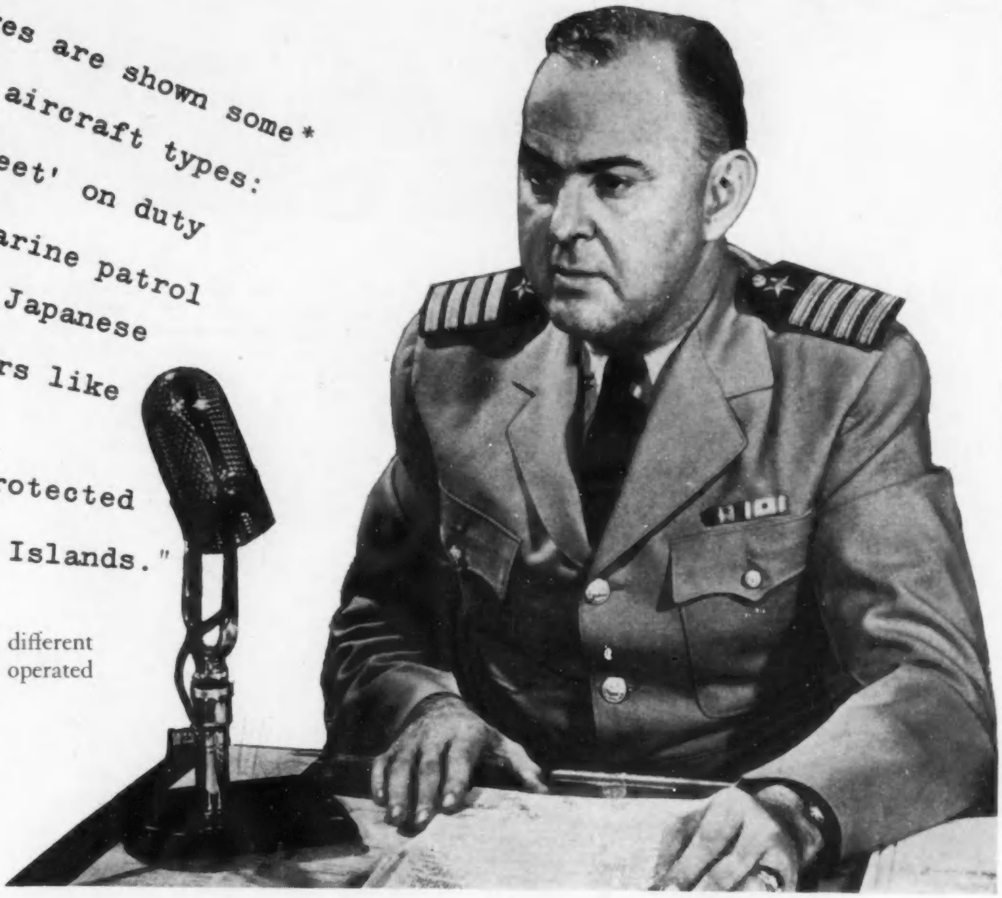
Photographs on pp. 38, 40, 42, and 44, are Official U.S. Army photographs.

Statement by Captain Lovette:

"On the following pages are shown some*
of the Navy's basic aircraft types:
The famous 'Eyes of the Fleet' on duty
with the Atlantic anti-submarine patrol
or scouring the Pacific for Japanese
task forces; torpedo bombers like
those used at Midway;
and the fighters which protected
our marines at the Solomon Islands."

* "These are but a few of over thirty-five different combatant and non-combatant plane types operated by the Navy's air arm."

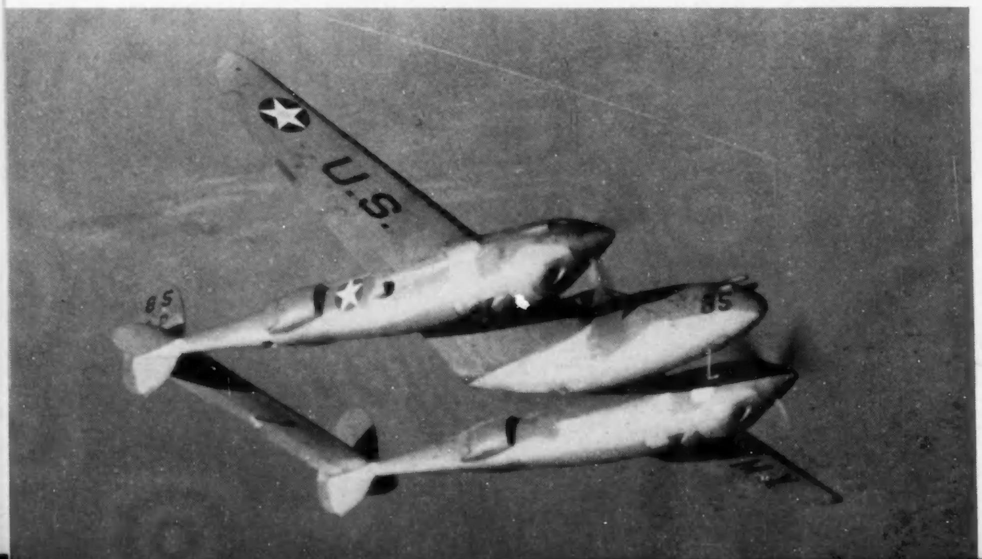
Capt. Leland P. Lovette, U.S.N., Director of Public Relations, U. S. Navy



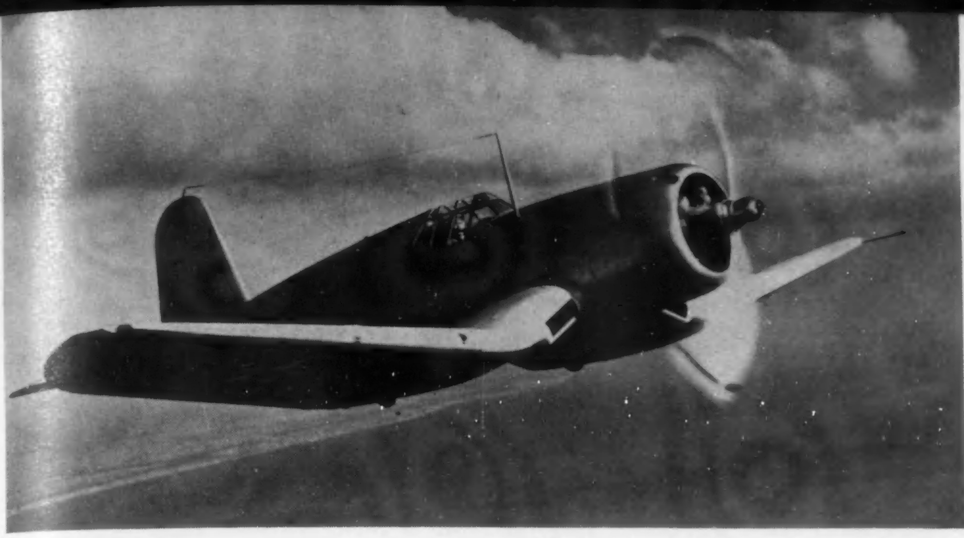
Photographs on pp. 39, 41, 43, and 45, are Official U.S. Navy photographs.

P-51 (North American "Mustang")
"This is a tough, speedy fighter plane whose specifications closely resemble those of the famous British Spitfire. It is powered by an Allison liquid-cooled V-type engine, has a speed of around 400 mph and excellent handling characteristics. It has recently been in operation with the RAF Army Cooperation Command, and has given a splendid account of itself over the invasion coast."

P-47 (Republic "Thunderbolt")
"A devastating high-altitude fighter plane, mounting six or more 0.50-calibre guns and heavily armored against enemy fire-power, is the Thunderbolt. Powered by an 18-cyl 2000-hp radial aircooled Double Wasp engine, the top speed is over 400 mph. A turbo-supercharger permits effective operation at 40,000 ft, the highest known ceiling of any fighter plane."



P-38 (Lockheed "Lightning")
"This is a twin-engine interceptor fighter capable of rapid climb to well over 35,000 ft, speed of more than 400 mph, and fire-power consisting of 20-mm cannon and heavy-calibre machine guns. It is in good quantity production and is just coming into action in various fronts. It is probably the fastest military airplane now in the air."



F4U-2 (Vought-Sikorsky "Corsair")

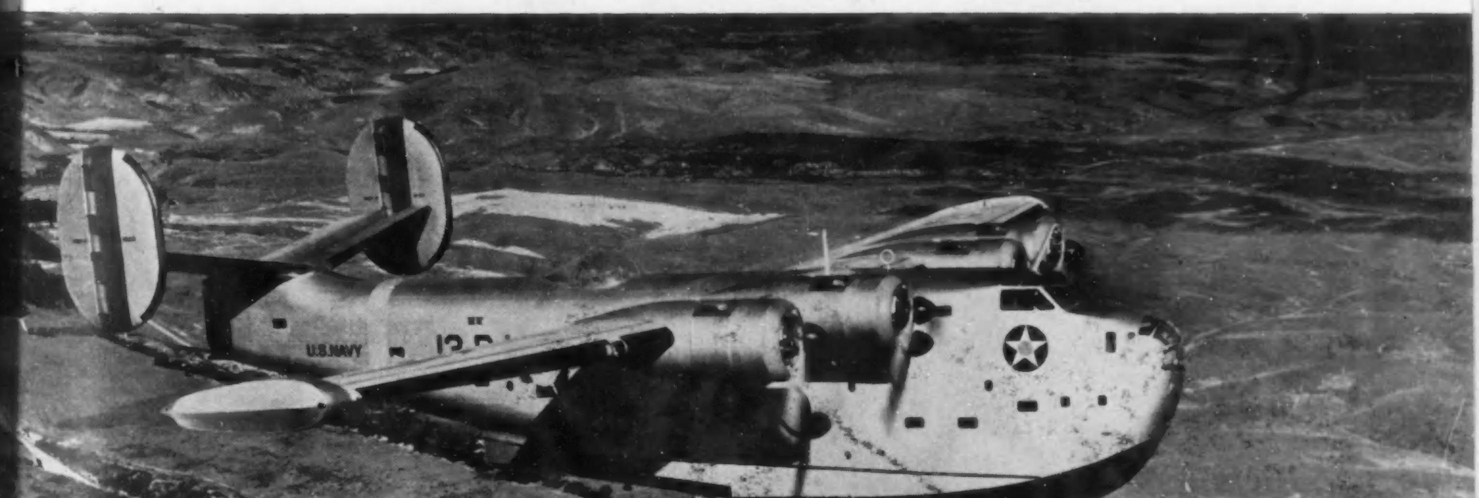
"As dangerous as the Mediterranean pirate whose name it bears, this long-range fighter is designed to climb 35,000 ft and then leave all pursuers behind. Its radial Pratt & Whitney engine develops 2000 hp to propel this lightning bolt upwards of 400 mph."

F4F-3 (Grumann "Wildcat")

"These fighters have been in the thick of the Pacific fighting, earning official commendation, while the company's factory flies a Navy 'E' pennant as its share. Armor protects the pilot and the gasoline tanks are bullet-proof in these 350-mph 'Wildcats.' "

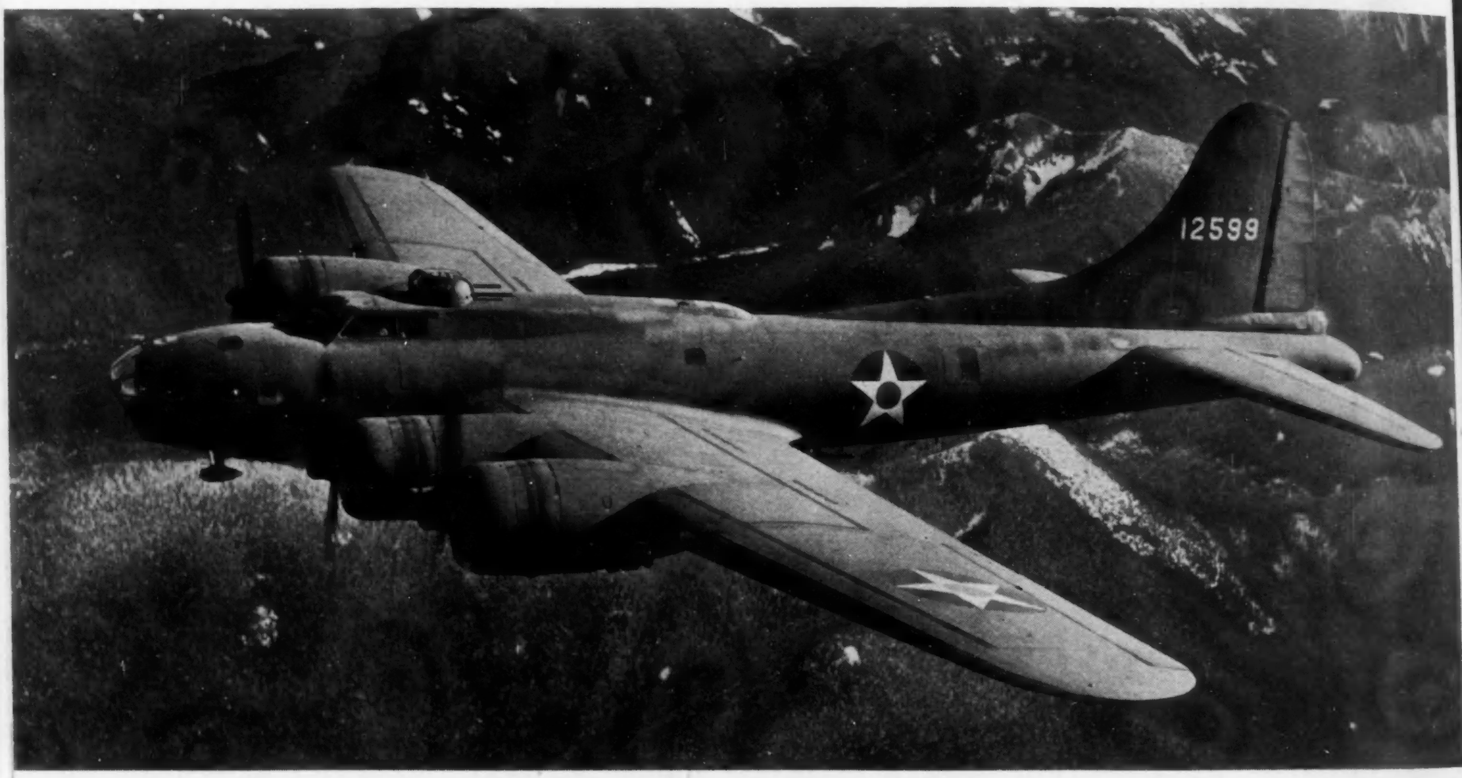
PB2Y (Consolidated "Coronado")

"The 'Eyes of the Fleet', these four-engined boats with retractable wing-tip landing floats carry 6 to 8 tons of bombs with ease, thanks to powerplants developing 4800 hp. Speed and range are restricted. The 'Coronado's' small sister 'Catalina' mauled the Japanese fleet at Midway."



P-39 (Bell "Airacobra")

"Distinctive features of this unorthodox fighter plane include 37-mm cannon firing through the nose of the propeller, Allison liquid-cooled V-type engine behind the pilot, and tricycle landing gear. These features provide devastating fire-power, excellent visibility, and ease of take-off and landings on improvised fields. The Russians regard the Airacobra very highly, both as an anti-tank weapon and in combat with all types of German aircraft."



B-17E (Boeing "Flying Fortress")

"The Flying Fortress is the world's first substratosphere heavy bomber. Developed for long-range operations, the B-17's have consistently battered their way through enemy fighter and anti-aircraft opposition, dropped heavy bomb loads accurately on their objectives, and returned to their bases in spite of savage punishment. Ten or more heavy calibre machine guns provide defensive fire-power from all angles, many of them in power-operated turrets. This makes the B-17E the most heavily armed bomber in any service."

B-24 (Consolidated "Liberator")

"The Liberator has the longest range of any operational aircraft now in service. Its reliability in 'round-the-world ferrying operations has been amazing, and it has played an outstanding role in the battle of the Atlantic. The British have called the B-24 one of the finest military aircraft yet produced. Liberators have been very successful in the difficult Middle East section. Like the B-17, this heavy bomber has four radial air-cooled engines, weighs about 30 tons, has a top speed well above 300 mph, and is heavily protected with 0.50-calibre machine guns."

SBD (Douglas "Dauntless")

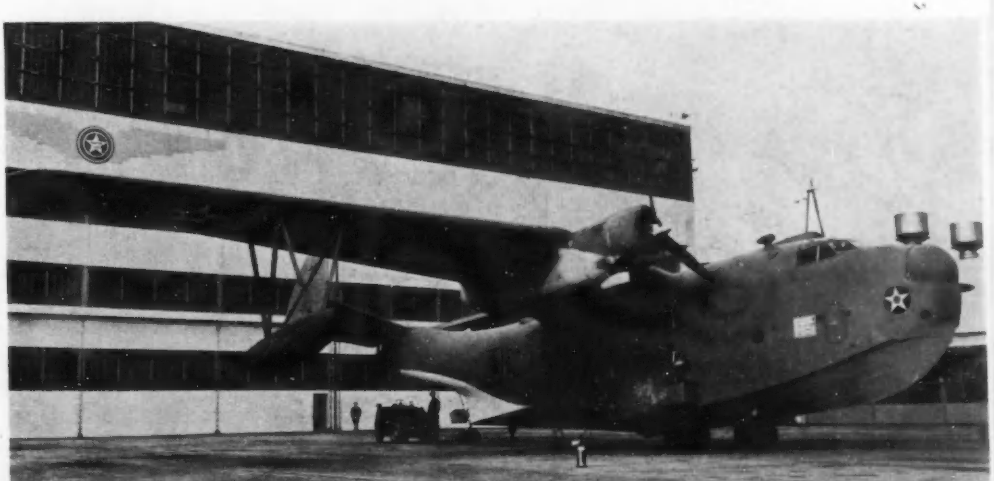
"The carrier's sting can travel 1000 miles in this 260-mph scout-bomber, the design for which developed from Northrop's famous dive bomber of 1937. The single Pratt & Whitney engine develops 950 hp. The 'Leathernecks' operate several squadrons of these bombers."

TBF-1 (Grumman "Avenger")

"The Navy's newest torpedo bomber (below), was one of the surprises that met the Japanese at Midway. The 'Avenger' ranges 1400 miles with 2000 lb of bombs or one torpedo, and can climb upwards of 20,000 ft."

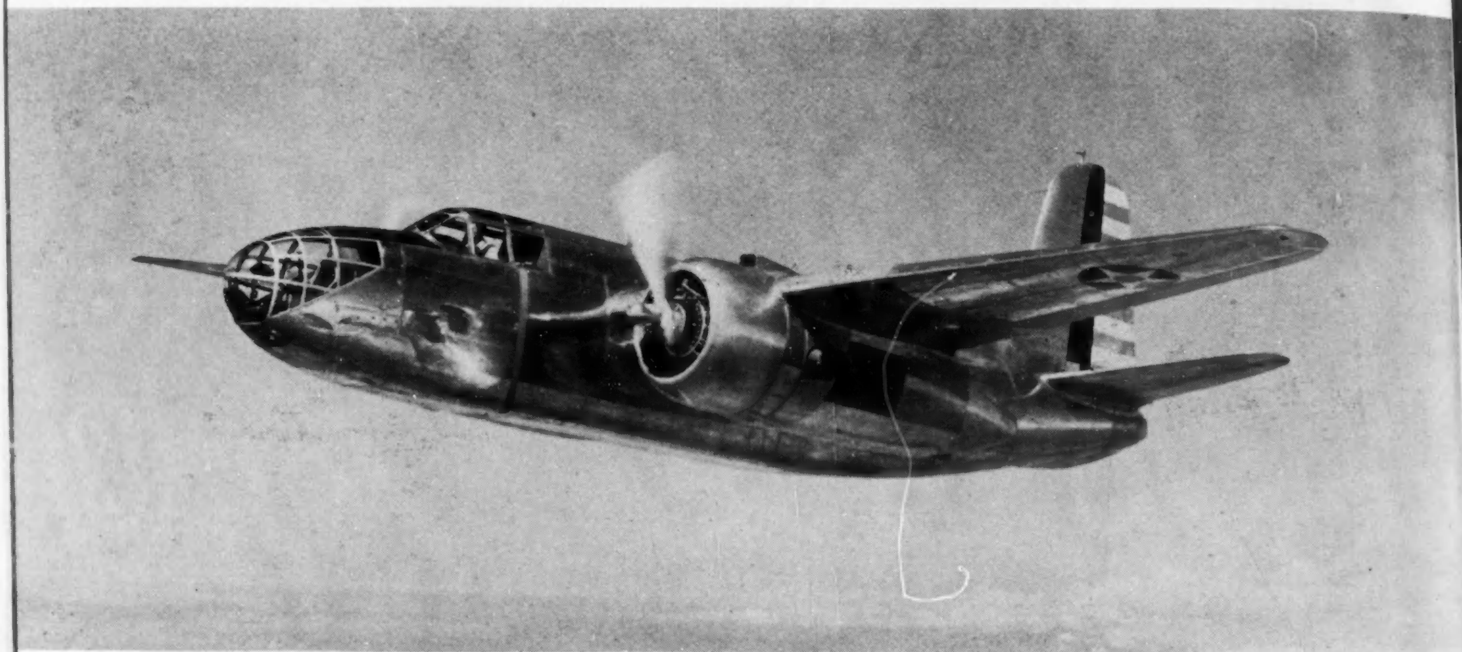
PBM-3 (Martin "Mariner")

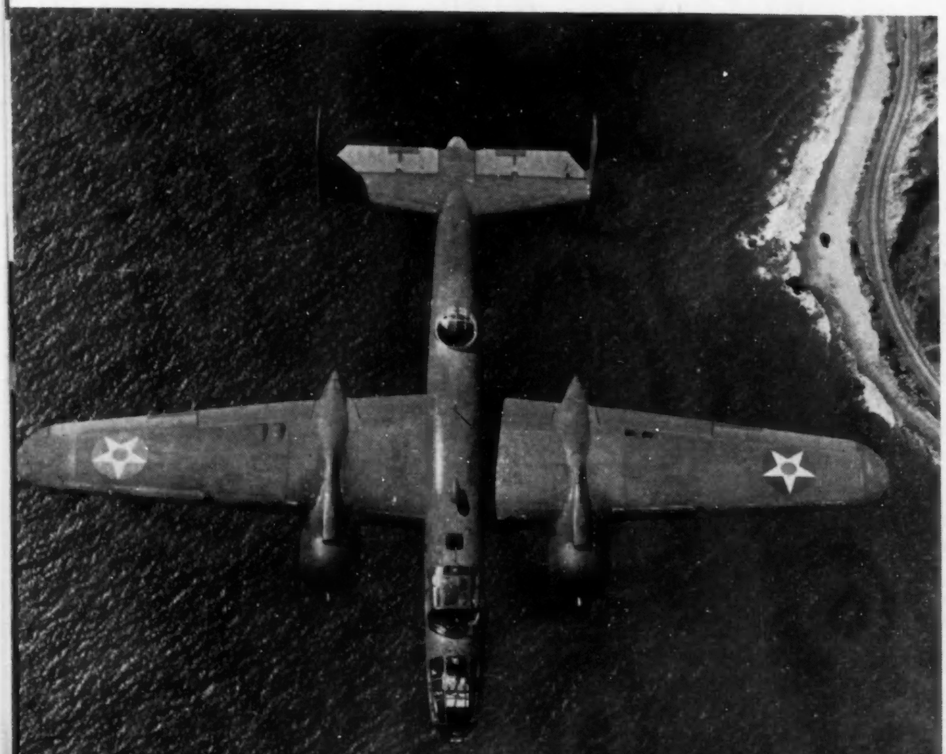
"This 40,000-lb monster can cover the round trip between Pearl Harbor and Seattle at 200-mph cruising speed without a stop. On offensive missions two 21-in. torpedoes or several tons of bombs are slung under the gulled wings."



B-26 (Martin "Martian")

"The Martian (the British call it Marauder), is a very clean, advanced design, probably the fastest, most powerful medium bomber in the air today. Its speed and heavy fire-power make it self-sufficient in carrying out raids over heavily protected enemy territory without needing fighter planes to run interference. The B-26's demonstrated their versatility by going into successful action as torpedo planes at Midway and in the Aleutians. The photograph shows is flying on one engine."





A-20 (Douglas "Havoc")

"The Havoc (above), is one of the most useful and versatile military airplanes now in operation. It was designed to combine the best features of the attack plane and a light, fast, low-flying bomber for cooperation with ground troops or short-range independent operations. Powered by two 1700 hp Wright Cyclone engines, the A-20C, called Boston III by the British, has a top speed of over 330 mph. It is a great favorite with air forces around the world."

B-25 (North American "Mitchell")

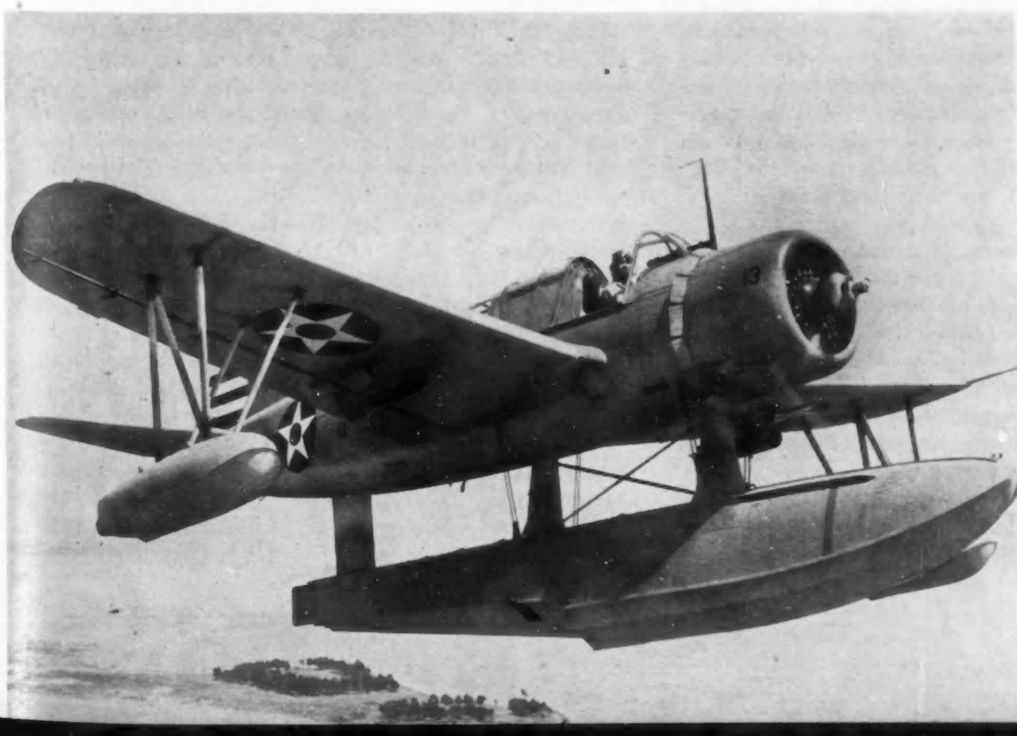
"The Mitchell (left), is classed as a medium-range bomber, carrying about two tons of bombs. Top speed is over 300 mph. In the famous Tokyo raid and the earlier raid of the Philippines from Australia, after dropping their bombs, these speedy, easily handled ships outflew the best fighter planes the Japs could put into the air. The B-25 is in operation over widely scattered fronts, including England, Africa, Russia, China, Australia, and is highly valued for anti-submarine patrol in this country."

SB2C (Curtiss "Helldiver")

"Sleek successors to the earlier biplane scout-bombers, the new 'Helldivers' are of all-metal construction and can lug their bomb load at upwards of 300 mph. These are some of the carrier-based planes now writing history over the Pacific."

SNJ (North American trainer)

"This advanced trainer is in use at the great 'finishing schools' of the Navy's air service. Pratt & Whitney 'Wasp' engines of 550 hp give these all-metal trainers a range of 900 miles and a cruising speed of 196 mph."



OS2U-3 (Vought-Sikorsky observation plane)

"Designed for high speed and maximum visibility this monoplane operates with the fleet to spot warship gunfire and perform light reconnaissance. Convertible for either land or sea, it is carried aboard battleships and cruisers and launched by catapult."

Aircraft MAINTENANCE Problems in

by ROBERT TOLAND
Lt.-Col., U. S. Army Air Corps

THE author, an outstanding authority on technical phases of shipping, has just returned from Africa with a report to Major-Gen. J. F. Miller, commanding general, Air Service Command, Army Air Forces.

He is Project Officer for India and China, Overseas Division, Air Service Command, AAF.

THE Americans and the British are not fighting the Germans and Italians in North Africa. The Allies and the Axis are *both* fighting against a common enemy – the desert.

There is little doubt that both belligerents would rather fight in some other part of the world – any other part – to get away from North Africa. This particular part of the world appears to be designed by nature to make fighting difficult. If the rest of the world were the same, there probably would never be any war at all.

It has been said that the North African war is "a tactician's paradise, but a quartermaster's hell." And the brunt of this falls on the aircraft maintenance men.

Sand is the main cause of the trouble, sand so fine that it gets into everything – food, water, fuel, clothes, engines, instruments, and especially moving parts – and there is no getting away from it.

The damage and discomfort created by sandstorms is legendary. The U. S. Army Air Forces and the RAF do not need to wait for sandstorms to have infinitely small pieces of sandy abrasive swirled into air intakes, pistons, and pumps. Every time an airplane takes off it creates its own sandstorm behind its propeller. Every minute an airplane is in the air it is reaming out its own cylinder walls, ruining valves, and in fact tearing down every moving part just as effectively as if a saboteur had sprinkled emery dust liberally throughout the engine.

■ Toll of Sandstorms

As a result, many moving parts that are good for 500 hr of flying in America will last only about 50 hr in North Africa. The dust cloud is found at altitudes as high as 10,000 ft, and every cubic yard of air taken in through the intake includes its quota of this microscopically fine sand.

One way to alleviate this difficulty, at least in part, is to install air filters which reduce the amount of sand intake. Unfortunately, in some instances they cut down the performance as well, so that filters that do reduce performance are not welcomed by the pilots, who rightly feel that they are entitled to every possible advantage of speed and climbing ability. A compromise has been worked out on some types of airplanes whereby the pilot cuts out the filter when combat is imminent, but this is far from an ideal solution to the sand and dust problem.

Another one of our maintenance headaches is the result of the Nazi tactic of strafing airports during bad sandstorms. Protected by the lack of visibility, enemy fighters or dive bombers can swoop down and raise hob before interceptors can be warmed up and flown into the air to meet them. For this reason aircraft are habitually held in readiness with engines idling on the field during a sandstorm. What this means in terms of worn-out moving parts is not difficult to imagine.

Sand is not, however, the only villain in North Africa. Wind, extremes of temperature, insects, sudden storms, lack of water, enormous distances, and disease must be included, too. Heat of 105 to 117 F (in the shade if any – and far more in the sun) is not only extremely uncomfortable; it means that metal parts which have been out in the sun are too hot to touch. At night, during the winter season, the temperature drops so rapidly that men must often huddle together in blankets to keep warm. This extreme range, which is typical of desert areas, is just as hard on machines that include fabric, rubber, and wood, in their construction, as it is on the men.

The lack of water is a story in itself. Water, soft drinks, and beer, are the most priceless commodities in the desert. The British, who will never give up their tea-drinking habits under any circumstances, hoard every drop of water to mix with a few tea leaves. And the Americans are fast learning the value of the British version of the "pause that refreshes."

Distances involved in the Middle East are enormous. The air distance from the western coast of Africa to Egypt is far greater than any transcontinental airline route in this country. Furthermore, there are few intermediate points. A crew forced down along its route may find itself hundreds of miles from any place where aid might be forthcoming. This route includes the dry desert of Sahara as well as the coastal region of Accra, British West Africa, where the yearly rainfall is 170 in.

Contrary to popular conception, the Sahara desert is not an area of gently rolling sand dunes, populated with picturesque camel convoys bearing spices and rare jewels. Nor is it confined to the northern part of the continent. Actually, it is a vast area, far larger than the United States, extending southward for half the length of the continent.

Perhaps, the desert may best be described as land containing nothing of use to man. Some of it is mountainous, and some is flat. There are areas with the familiar Sahara sand dunes, but a far greater part of it is nondescript country, void of trees, rivers, lakes, and centers of human habita-

S

in NORTH AFRICA

Creating its own "sandstorm," this Curtiss P-40 Kittyhawk is making a lot of work for its maintenance crew in a desert of the Middle-East Front. "In the desert it is doubly true that an airplane is no better than its maintenance . . . " the author says.

tion, filled with rocks, insects, and sand, and capable of the most violent winds, and the most drastic changes of temperature possible to imagine.

All of this means that aircraft maintenance presents extraordinary difficulties. The requirements for parts and replacements are about ten times what they would be any place else. The burden of aircraft maintenance makes the mechanic a key man in this strange warfare. Supplies must be flown in to the combat area by air as much as possible.

A ten-knot freighter can make only two and one-half round trips a year between New York City and Aden. Air transportation can do the same thing in a few days. There have been some amazing examples of how much time has been saved through transporting men and equipment by air. To cite just one instance: Sometime ago, it was found that a certain airplane part was necessary due to the climatic conditions. It required the attention of an expert, who was employed by a certain firm in America. To transport that expert by water from America to Libya for a survey of the situation, then back to America to supervise the manufacture of exactly what was required, and thence back again to Libya with the new parts, would have taken the better part of a year. During this time dozens or perhaps hundreds of airplanes might have been grounded, as a result of only one needed part.

By air, the same thing was done, and done to the complete satisfaction of all concerned, within three weeks. What might have been a major handicap to the war effort in North Africa was turned into a minor and temporary inconvenience, thanks to air transportation.

The American and British air forces both owe a great deal to the superb cooperation which the aircraft industry has provided for the maintenance of aircraft in the North African theater. "Trouble shooters" from the factories have ironed out many of the "bugs" which aircraft have developed under the difficult conditions prevailing. Special repair units have done yeoman work. As a result, American-made aircraft have been giving a splendid account of themselves. The later P-40's have been excellent as a medium-altitude desert fighter. The British swear by our Douglas "Boston" light bombers. And our heavier bombers, the B-25's and B-24's, have been second to none. In the desert it is doubly true that an airplane is no better than its maintenance, which depends in large part on the Air Service Command.

■ Improvision in Maintenance

The desert air war requires considerable ingenuity in many different ways. Protection of aircraft from the talc-fine sand, the heavy dew encountered in some areas, and the range of temperature, requires constant attention. Mobile field units equipped to handle practically every maintenance need and cleverly improvised stands and derricks have proved their worth during months of hard use. But perhaps the most spectacular means of making repairs on damaged aircraft is the huge tractor and trailer combination known as the "Queen Mary."

Whenever any airplane is forced to land on the desert,

because of combat damage or mechanical failure, it is a standing target for any Axis warplane. No airman can last long in that stifling heat without water, food, or suitable shelter, nor can he radio his plight. Aid must be brought to the stricken flyer as quickly as possible. As soon as he is spotted by one of his own aircraft, that aid is dispatched in a hurry. A maintenance airplane flies to him and lands. If he is injured or wounded, the pilot is given first aid before the trip back to the base. Meanwhile, the rescue crew surveys the damage. Minor repairs may be all that are necessary to enable the plane to be flown back.

But chances are, it will need the services of a mobile repair unit.

Soon, the unit arrives on the scene, with trucks, cranes, or tractors. Perhaps a new engine must be installed to replace the damaged one. Perhaps the airplane is so badly damaged that it cannot be made airworthy on the spot. Then it is loaded onto a salvage trailer. The wings are taken off and stacked alongside the fuselage. All parts are carefully padded to prevent injury in transit, and the strange caravan goes back across the desert.

All this is extremely dangerous and difficult work. It must be done as rapidly as possible, and often at night in blacked-out darkness, for there is no concealing the operation from the aerial observer. At any moment, a swarm of enemy airplanes may swoop over to bomb and strafe the helpless crew. It is work to test men's patience, stamina, and courage, but it is being done with surprising efficiency.

But even back at base, conditions are often little more luxurious than in the heart of the desert no-man's land. There is little or no means of protecting men or machines from the elements. Life is full of minor annoyances. Small stones on the field are picked up in the propeller slipstream and damage the blades. So the field must be regularly and religiously combed for every stone and pebble, a far more gruelling task than the traditional "snipe hunt" for cigarettes and pieces of paper at an army post.

Other annoyances that plague the desert air fighters and maintenance men include some of the native workmen, who have shown amazing ability to steal parts and hide them in their flowing white robes. Consequently, every "WAD," as a native worker is called, must be examined as he leaves camp. Often, a poke at a suspicious bulge in the clothing will reveal anything from a sack of cement to a piece of wire. The light-fingered native invariably has "no idea" of how that particular piece of loot happened to become entangled with his clothing.

So ingenious are these light-fingered natives that a group of them was once credited with taking a tank apart and carrying all its parts away for sale as scrap metal.

Another major nuisance stems from the fact that North Africa undoubtedly has more insects and flies per person or per square mile than any other place on earth. An experienced desert soldier may always be spotted by the way he instinctively covers his cup with his hand immediately before and after each sip, so that he may enjoy his priceless beverage without swallowing insects or sand along with it.

Always good-humored and adaptable to conditions like these, the Americans and the British have turned to insects for amusement in this land of little entertainment. Scorpion fights are practically the universal sport. Placed in an improvised arena, these vicious insects frequently "perform" before large and enthusiastic audiences. No fighting cock was ever more profoundly cherished by its owner than a scorpion of proved combat ability. Champions are sold for bottles of beer, the great common denominator of value among desert soldiers. Some soldiers become celebrated for their abilities as "fight managers" and matchmakers.

The Americans and the British, together, are doing a splendid job in the forlorn desert battleground of North Africa. They are learning how to adapt themselves and their machines to the heat, the sand, the dryness, and the biting wind. Their ability to face hardships and danger, both in combat and in maintenance, their sense of humor, and native intelligence are the best guarantee of victory.

AIRCRAFT DESIGN and Combat Performance

by MAJOR NATHANIEL F. SILSBEE
U.S. Army Air Forces

ALL airplane design is a compromise. A friend recently approached Lt.-Gen. H. H. Arnold with a model of a new airplane which he said would carry a heavy load of bombs for a long distance, was fast and maneuverable enough to avoid enemy fighter action, and would land at a safe low speed. The General wished him the best of luck, but remarked that he had never yet heard of a horse which could win the Kentucky Derby and at the same time haul a heavy coal wagon.

Each desirable quality in performance calls for a certain property, and the various properties conflict with each other to a remarkable degree. The aeronautical engineer's knowledge of his subject tells him what properties are necessary to produce the particular qualities he desires, and his skill or creative genius guides him in so adjusting the mixture as to obtain the most while sacrificing the least.

★ ★ ★

"YOU can't have *everything* in a military plane." Major Silsbee, noted aviation writer and expert, now a member of the Army Air Forces, underscores again and again that "all airplane design is a compromise."

Then, in this exclusive article, he takes apart the various types of plane being used by both the Axis and United Nations, tells what combat experience has taught about each, and explains the special purpose of many specific design features.

Here is a frank, penetrating analysis of the combat performance questions which are uppermost in engineering minds today.

★ ★ ★

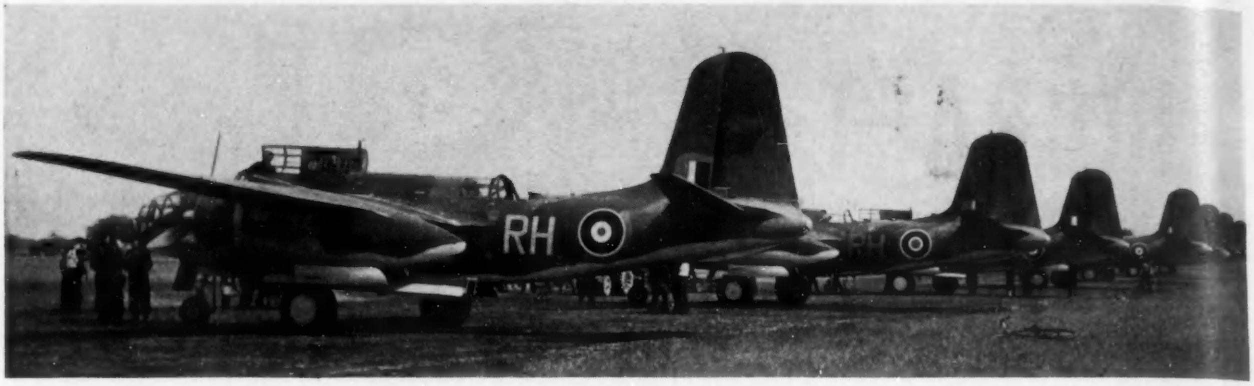
Thus it is practically impossible to get a high top speed without increasing the landing speed, sometimes beyond the safety point, particularly in combat areas where large modern airfields are not available. This design may produce what is popularly known as a "hot" ship, although it should be pointed out that this phrase really means a speedy high-performance plane which, if mastered by the pilot, may prove to be actually safer to handle, both in the air and in landing. An example of the danger is the original German Heinkel He-113, a beautiful and cleanly designed fighter, but which landed so fast it proved a pilot-killer; it has since been redesigned, and has become a useful fighter plane, second only to the Messerschmitt Me-109F and Focke-Wulf F.W.-190.

The best-known current example of the fact that "you can't have everything" in a military airplane is the Mitsubishi-00 Navy fighter, or Zero. To secure maneuverability, rapid climb, and high ceiling not only were all pilot safety factors sacrificed, such as protective armor and self sealing gasoline tanks, but durability as well. Aluminum sheeting is very light, and the general construction far from rugged. Evidently both planes and the pilots are classed as "expendables," like bombs, guns or other items.

■ Air Power Ingredients

To gain the air superiority we need if our side is to win this war, America must have a sufficient quantity of high

[This paper was presented at a meeting of the Metropolitan Section of the Society, New York, N. Y., Sept. 17, 1942.]



British Official Air Ministry photograph

Line-up of RAF Boston III daylight bombers (Douglas A-20 light bomber)

quality *airplanes*. We must have hundreds of thousands of well trained *air men* – and that means air crews, such as bombardiers, navigators, pilots and gunners, and also ground crews to "keep 'em flying." Finally, we must have *air bases* at strategic points, including landing fields, storage and maintenance facilities, housing and technical installations, and all that goes to enable a modern air force to carry on. Our training programs, under the Flying Training Command and the Technical Training Command, have been expanding at an amazing rate, and well-trained air crews and ground crews are coming out by the thousands every month. Our engineers and construction crews have been busy for well over a year establishing the necessary air bases for action in the main theaters of combat. In this paper we are concerned principally with the airplanes, but don't forget the other two elements in making up a balanced and powerful striking air force. Some of the following points will appear elementary to many readers but, in estimating our progress in the race for air supremacy and in order to evaluate properly much of the current discussions of our airplanes, it is important to get down to brass tacks.

■ Warplane Types

In discussing airplanes it is important to remember that mere numbers, such as 50,000 or 100,000 per year, mean very little. The questions to ask are: "What exactly are these planes to be used for? What types do we need? How many of each?"

The basic functions of air power include: (1) air attack; (2) air fighting; (3) air observation; and (4) air transport. Out of experience in the use to which airplanes are put, certain general specifications have emerged. Military airplanes are designed by aeronautical engineers to meet certain specifications as to exactly what that airplane is expected to do. Each model is a tailor-made job. It would be very convenient and far less expensive if a single type of airplane could be designed and produced which would perform all functions, but that simply is not in the cards. As we shall see presently, certain aircraft which we have developed have proved surprisingly versatile in actual use and, with minor modifications, are performing three or four different chores better than anyone had a right to expect. The best example is the Douglas Havoc (A-20) light bomber, used by the RAF Bomber Command as the Boston III for short-range raids in occupied France and the Low Countries, and by the RAF Fighter Command as a day fighter, and specially adapted for night fighting as the Havoc II. The A-20 also is being used successfully as a fast low-flying attack plane in the deserts of North Africa and in Russia, and in the southwest Pacific once again as a speedy light bomber. Recent reports show the Havoc being used successfully over occupied France and the Low Countries by American units in the new role of *dive bomber*. It just about completes the circuit when we note that some of the newer models have been equipped to carry *torpedoes*. Here is versatility plus, but the reason is that specifications for this attack bomber type (as distinctively an American development as the long-range heavy bomber) are far less contradictory than for other more standardized types, in addition to which the exigencies of warfare have a way of prodding human ingenuity in no uncertain terms!

The main combat types are fighters and bombers, and the service types are observation planes, cargo and transport, and trainers, including primary, basic, advanced single-engine (for fighter-pilot training), and advanced twin-engine (for training of bomber pilots, bombardiers, navigators, aerial gunners, and so on). For the most part in the remainder of this article we shall consider only the combat types. Each of these types has definite design specifications to meet certain performance requirements.

■ War from the Air

Two of the four functions of air power that we mentioned are air attack and air fighting. Of these air attack is fundamental, and air power should be regarded not as primarily concerned with airplanes fighting *in* the air, but as attacks on vital ground objectives *from* the air. This spells bombers, backbone of any air force. The bomber primarily must be a good weight carrier, with sufficient range to reach distant targets and return, with allowance for adverse conditions. The yardstick for both heavy bombers and cargo planes is power-loading – the gross weight divided by the total horsepower, and the fewer the pounds per horsepower the better. A good average at present is between 12 and 13 lb per hp (C-47 cargo carrier and B-17E heavy bomber are both about 12.5). From a design standpoint this requirement means a large airplane with high-lift wings, and this condition limits its maneuverability. To secure greater range, larger fuel capacity may be provided, but this provision correspondingly reduces the bomb load. This is one of the important differences between the British heavy bombers, such as the Stirling and Lancaster, and our long-range Fortress (B-17) and Liberator (B-24). The former were designed to carry

huge loads of bombs (6 to 8 tons), for relatively short distances (targets within a radius of 500-600 miles), at medium altitude (12,000 to 18,000 ft). American heavy bombers were developed for high level daylight precision bombing of specific targets, and at long range.

These characteristics are fundamental for a bomber, but hardly less important are the factors of *speed* so that enemy fighter planes will not be able to fly rings around it, and ability to carry its heavy load to high *altitudes* in order to escape the worst of the increasingly effective anti-aircraft fire which has been developed by practically all the belligerent nations, now effective up to approximately 25,000 ft. Superior horsepower, sometimes known as "supe," and gear-driven or turbo-supercharging are the answers to these problems. From a military standpoint a correlative to high-altitude performance is the precision bombsight.

■ Dive Bombers

An excellent example of the need of highly specialized design to meet specific performance requirements is the dive bomber. For more than twenty years dive bombing has been a specialty of our Navy and Marine Corps pilots and, as is well known, the idea was seized by the *Luftwaffe* in the early thirties and developed in the Spanish Civil War. The Junkers Ju-87 "Stuka" (from *sturz kampf* or "diving fighter") was used with devastating effect in the Nazi campaigns of 1940. In the meantime, the Army Air Corps continued its development of *attack* aviation (now included in light bombardment), using fast, low-flying planes for ground strafing of troops, ammunition dumps, machine-gun emplacements, and so on. The Stukas proved extremely vulnerable if local air superiority was not obtained; this fact was proved not only in the battle of Britain, but in recent action in the desert, where Rommel lost Ju-87's by the score, with the RAF losing practically none of their Douglas Bostons. However, under certain conditions on land, and definitely at sea, the dive bomber may fill an important place as a specialized type.

Although there are still large numbers of the five-year-old Ju-87's in service, the real dive-bombing threat of the *Luftwaffe* is the twin-engine Junkers Ju-88B which came out in 1939. Also used as a level bomber for short-range bombing and long-range reconnaissance, it is claimed as the first bomber in the world to exceed 300 mph. This "all-purpose" bomber, the Heinkel He-111K, and the Dornier Do-217Z constitute the backbone of the *Luftwaffe* striking force, as four-engine heavy bomber types have not been extensively developed in Germany. The Japanese have used dive bombers very effectively in both their sea-air and land-air campaigns.

Our Navy and Marines use the Douglas SBD Dauntless, and the Army Air Forces have a similar version known as the A-24. The important feature is the hinged metal surface attached to the trailing edge of each wing, which cuts the diving speed to about 250 mph. The Vultee Vengeance (A-31) is a newer model built for the British. The Army equivalent of the Curtiss SB2-C, Navy's Helldiver II, is the A-25 which is expected to be the most powerful dive bomber in any service. A dive-bomber version of the North American Mustang (our P-51) is now in production for the Army Air Forces.

■ Speed for Fighters

Air fighting is hardly less important than air attack, and has two main purposes: The first is defensive, the interception of hostile bombers. The second is offensive, gaining air superiority during an attack. For this two-fold purpose modern fighter planes have been developed by the various countries which, on the whole, have similar characteristics and performance.

The conflicting requirements for a single-seat fighter plane constitute an aeronautical engineer's nightmare. First of all is *speed,* speed sufficient to exceed that of enemy bombers and also enemy fighter planes, and this speed at any and all altitudes. This problem of superior speed at any altitude is one of the most difficult of all. Owing to the fact that engine horsepower falls off as the airplane goes higher and higher, every military plane has a critical altitude at which it performs best, depending on the supercharger.

An excellent illustration of this point is found by some information on the engine data card found in the cockpit of a German Focke-Wulf F.W.-190A3 shot down by the RAF Fighter Command on the south coast of England recently. Its rates of climb show "3050 fpm at 4000 ft with supercharger in M gear, and 3280 fpm at 17,500 ft, supercharger in S gear."

■ High-Altitude Fighters

As compared with the two-ratio or three-ratio gear-driven supercharger, the turbine-driven supercharger is somewhat more flexible and provides a greater spread of altitude at which maximum horsepower can be obtained. The design compromise on this matter of high speeds at all altitudes has not as yet gone beyond the stage of practically two types of fighter planes for our Army Air Forces, those of critical altitudes of about 13,000 ft with a service ceiling up to 25,000 ft, and the distinctively high-altitude jobs which operate effectively up to 38,000 or 40,000 ft with turbo-superchargers. (We don't know yet if these or any planes can *fight* effectively up that high). In the first class we have the Curtiss P-40 series, the Bell P-39 Airacobra, and the North American P-51 Mustang. In the high-altitude class we have the Lockheed P-38 Lightning with two Allison supercharged engines, and the Republic P-47 Thunderbolt, which is powered by a 2000-hp Double Wasp radial aircooled engine. The British use the Hurricane as a rule for the low and medium levels, and the newest Spitfire Mark Vb for high-altitude work; the Hawker Typhoon, with Napier Sabre 2200-hp engine has been reported in production, and will be faster than either of these and also effective at high altitude. The Germans have three first-line fighters, all with high ceiling. Of these the Heinkel He-113 is the fastest, powered by a Daimler-Benz 603 inverted V-engine of 1300 hp, but the other two, the Focke-Wulf F.W.-190, and especially the Messerschmitt Me-109F, are more effective at very high altitudes.

Second only in importance to speed in relation to altitude is rapid *climb.* If enemy bombers approach at say 20,000 ft flying 300 mph, they will penetrate five miles every minute. If the fighter planes require six or seven minutes to reach a 20,000-ft altitude, the bombers will have progressed between 30 and 35 miles during that time. A fast rate of climb insures ability to intercept the enemy more quickly. This is a feature very prominent in German design, and it is of interest that the Jap Navy Zero has this as its leading characteristic. The present standard is somewhat better than 3000 fpm.

The conflict of design features as between the qualities of high speed and fast climb resolves itself to this: Speed

requires high power and low drag (resistance), *small* wing area and highly streamlined contour. Climb demands high power and *large* wing area compared with total weight, or what is known as a light wing loading. Net result, as usual: a compromise.

■ Fighter Armament

These characteristics have to do with fighters as airplanes. They are also weapons. Chief of the military features of a fighter plane is *fire-power*. In the last analysis no combat ship is better than its armament. It was the edge which the eight 0.30-calibre guns on the Spitfires and Hurricanes, plus slightly higher speed as compared with the Messerschmitts and Heinkels, which was in large part responsible for winning the air battle of Britain.

Today eight 0.30-calibre machine guns is an absolute minimum, and most of the modern fighters have combinations of two to four 20-mm cannon with two to four or more 0.30- or even 0.50-calibre machine guns. Instead of these mixed mountings, some fighters have four 20-mm cannon (Hurricane IIc, Spitfire Vc) or six 0.50-calibre machine guns (Warhawk, Thunderbolt). This additional fire-power is necessary owing to the greatly decreased vulnerability of modern bombing planes, with their increased speed, sturdy metal construction, leak-proof gasoline tanks, and armor protection for crew and vital spots.

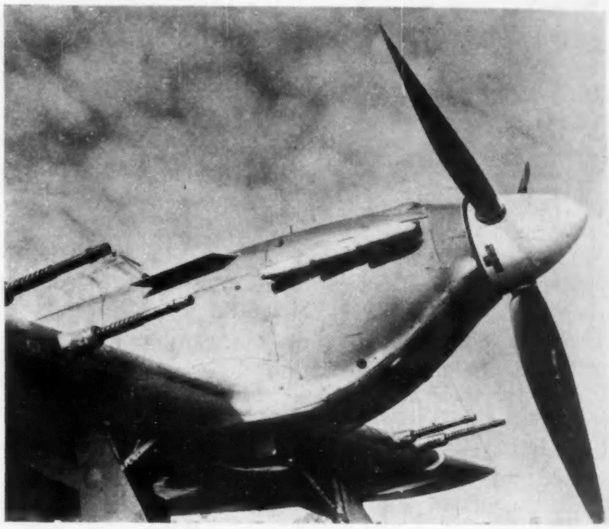
The heavier 0.50-calibre machine guns firing at the rate of 800 rounds per min are much more effective, and at greater distance, than the rifle calibre 0.30's which fire at the rate of 1200 rounds per min. American armament experts on the whole favor the 0.50-calibre gun, while most of the British, German and other foreign military aircraft use combinations of the 20-mm cannon and 0.303-calibre or 7.7-mm machine guns. This insistent demand for more fire-power increases the weight, and this added weight reduces the speed, and especially the rate of climb.

■ Other Qualities

Besides these three fundamental characteristics of speed, climb, and fire-power, fighter planes must have other performance features. Among these is *maneuverability,* an adroitness and flexibility enabling the plane to be stunted rapidly and easily through a series of turns, rolls, dives and other aerobatic maneuvers. The fire-power is directed by maneuvering the plane into position and, in addition, maneuverability is the principal means of defense in combat with enemy fighter planes.

A good fighter plane must have clear *visibility* to enable the pilot to scan the skies in all directions to discover his opponents and to avoid being surprised. It must have good *handling qualities* for landing and taking off from fields with restricted areas. It must be of simple, rugged construction permitting easy *maintenance* in the field, including hatches providing easy access to the engine. This quality is highly important, as time is at a premium in war, and grounded fighter planes may be worse than none.

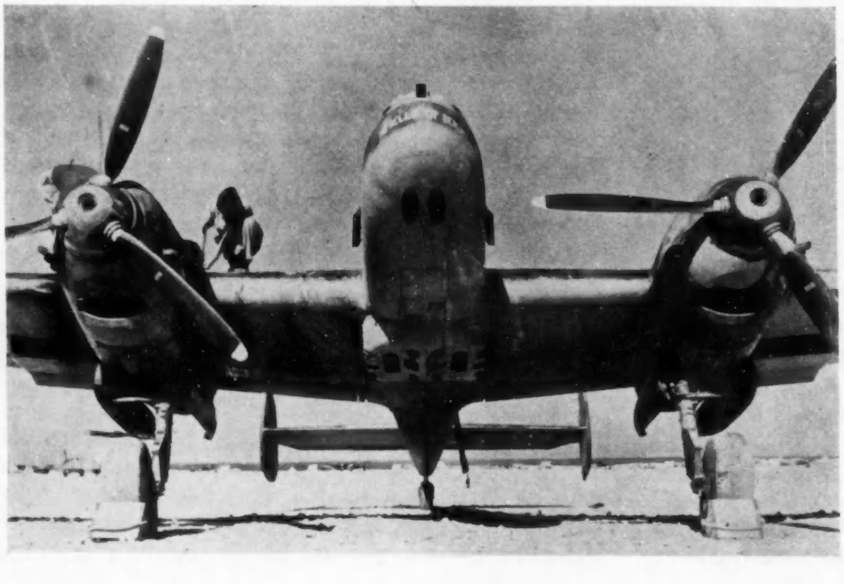
These qualities have largely to do with what has hitherto been called the interceptor fighter, used defensively to intercept enemy aircraft, for protection of friendly aircraft in short-range operations by destroying the enemy's fighter planes, or providing an umbrella for task force operations. (It should be noted that, although the "P" designation remains, the term "pursuit" ship has been superseded by "fighter" as more generally suitable.) Another function of the fighter plane, however, is that of escorting bombers on long-range missions. As yet, no country has been able to solve in any satisfactory manner the aeronautical prob-



British Official Air Ministry photograph

(Above) Close-up of a Hurricane II, high-speed fighter armed with four 20-mm cannon

The Hurricane II is an improvement over the Hurricane fighters used during the Battle of Britain in the summer of 1940. It is fitted with a new Merlin engine and the armament has been improved. There are two versions: one has 12 machine guns against the eight previously carried, and the other has four 20-mm cannon



(Left) "The Belle of Berlin" – Messerschmitt 110 captured by the British in the Middle East and reconditioned for use by the RAF for communication work. Nazi crosses have been replaced by RAF circles

British Official Air Ministry photograph

Hurricane bomber in flight showing bombs fitted to streamlined racks

To increase the power of the RAF Fighter Force in low-level attacks on shipping and ground targets, Hawker Hurricanes are now equipped to carry bombs. Fitted with delayed-action fuses to enable the aircraft to get clear before the explosions when bombing from low level. The bombs form a powerful addition to the fighter's already formidable armament. The Hurricane is powered with a 1330-hp Merlin engine and carries its extra load without appreciable loss of maneuverability

British Official Air Ministry photograph

lem of providing a fighter plane with sufficient gasoline-carrying capacity to give a range of say 2000 miles (and this means a *radius* of bomber action not more than 800 miles, or 40% of range), without unduly sacrificing such primary fighter plane characteristics as speed, climb, and maneuverability.

It will be recalled that, on the first few raids of our Boeing B-17E Flying Fortresses over occupied Europe which began about the middle of August, they were escorted by RAF and AAF pilots in Spitfires. These raids, such eye-openers to the British as to the possibilities of daylight precision bombing, were all short-run affairs. In the longer raid over the North Sea a few days later, as soon as the fighter escort turned back to England, the last five of the eleven Fortresses were violently attacked by a swarm of Focke-Wulf and Messerschmitt high-altitude fighters. Net result, one Fortress severely damaged, but all returned safely to base after dropping bombs on their targets; three Nazi planes down in flames and nine others damaged or destroyed.

All of which illustrates two things: At present long-range bombers cannot have fighter interference running all the way. It is when the escort fighters leave that trouble begins and is likely to increase as the mission flies farther into enemy territory; in other words, at the very time when the fighter protection is most needed it is not available.

Can Bombers Be Independent?

The other point involved is likely to make history. This incident, backed by scores of similar examples of the Flying Fortresses in the Pacific area and an increasing number of instances of British Stirlings and Lancasters, proves that substantial progress has been made in the last year or two toward the ideal of a heavy bomber able to look after itself, and thus independent of fighter escort. Over and over again these bombers, and our two-engine Douglas Havocs, Martin Martians, and North American Mitchells in every important theater of operations have demonstrated that their high speed, heavy fire-power and sturdy construction are more than a match for enemy anti-aircraft and fighter opposition. The record to date is a B-17E which returned with two engines out of operation, tail surfaces almost shot away, and nearly 1500 bullet holes.

Fighter Range

The average tactical range of British and German single-seat fighters is 600-700 miles, with a radius of action of 200 to 250 miles, or 35%. In heavy action, as a practical matter, it is considerably less than this maximum figure. According to *The Aeroplane* (London), clear-cut air supremacy can hardly be achieved with present equipment (Hurricanes and Spitfires) beyond a radius of 75-80 miles. American fighters and Jap Zero range about 900 miles and, to increase the range for ferrying or strategical purposes, jettisonable belly tanks recently have been provided. Until the difficulties of a genuine long-range fighter are resolved, and there are obvious advantages in having a fighter plane with sufficient gasoline capacity to stay in the air several hours, a partial solution will continue to be found in the use of fast, heavily armed two-engine light bombers like the tough, speedy Douglas Havoc or the powerful British Beau fighter. These two ships, incidentally, are far and away the best night fighters now in operation, a highly specialized job in itself.

When all these conflicting qualities of speed, climb, fire-power, maneuverability, visibility, ease of handling and maintenance are added up, especially if *range* must be thrown in for good measure, the result is more of a compromise than is found in any other airplane type. The Army Air Corps awards the design of a new type of plane to manufacturers as a result of a competition based on announced general specifications. Merit is measured in terms of: (1) performance, including speed, range and ceiling, 350 points; (2) engineering features, including structure, armament, powerplant, and equipment installations, and maintenance, 350 points; and (3) military features, including general suitability, landing and take-offs, arrangement of guns, and so on, 300 points.

Fighter Plane Development

It is not generally realized that many of the first-line military airplanes in the forefront of today's aerial combat are the result of tried-and-proved designs first brought out six or more years ago, vastly improved as to speed, ceiling, and especially fire-power, but still essentially the same airplanes.

In the fighter class the best examples are the famous Hurricanes and Spitfires. In 1934 the British Air Ministry issued a specification for an eight-gun fighter with 1¾-hr range at full throttle. (The long drag-out fight to get the *eight* 0.303 guns into the specifications was something else again. Such heavy armament was unheard of in those days, but the concentrated shotgun fire-power thus provided saved England in 1940.) Sydney Camm designed the Hurricane and Reginald J. Mitchell, the Spitfire. Using the Rolls-Royce Merlin, both fighters were test-flown in 1936; came into limited production in 1937; and the first squadrons were outfitted in the summer of 1938. The Hurricane had a top speed of 335 mph and the Spitfire 365 mph. Improved versions of the Merlin and refinements in design have more than kept pace with the demands for more protective armor and increased fire-power, as the

British Information Services photograph

Spitfire Mark V – latest of a long line, improved vastly in speed, ceiling, and fire-power since the first Spitfire was brought out in 1936

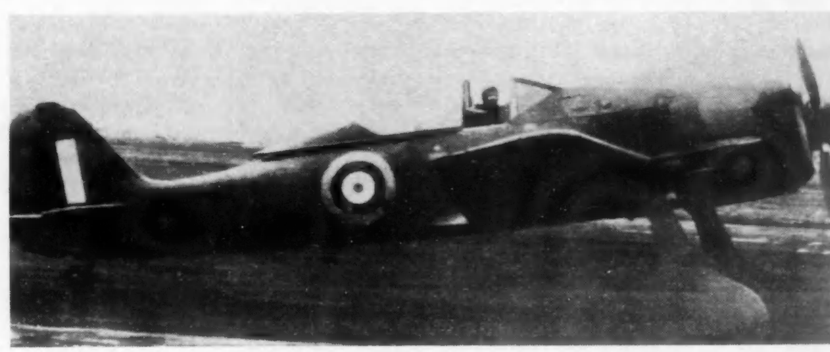
in its expansion program which began a year or two later. The highly successful P-36 was redesigned slightly to take the new Allison V-1710 (then turning up 950 hp) as the YP-37, which was developed into the P-40A, B, C (British Tomahawk), and the P-40D and E (Kittyhawk) with much heavier firepower, self-sealing gasoline tanks, and increased armor protection. The newest model P-40F or Warhawk has the Packard-built Rolls-Royce Merlin XX engine and has a higher critical altitude and service ceiling than the earlier models and, according to reports from the various fighting fronts, this change is already showing up in favorable action, although no details are releasable.

newest models are 5 or 10 mph faster than the originals and, in the case of the Spitfire Mark V, the critical altitude has been boosted.

The German Messerschmitt Me-109 was brought out in 1936 and came into full production in 1937, its final design having been influenced largely by experiences gained under conditions of real combat in the Spanish civil war. This statement is also true of the newer Russian fighter planes. This experience set the seal on the monoplane fighter with retractable landing gear as the fighter type of the immediate future. The Me-109 was designed originally for an engine of 650 hp and was the first fighter to use a 23-mm shell cannon firing through the propeller hub. Without material change of design the powerplant has been stepped up successively to 850, 1050, and now 1150 hp, as found in the Me-109F. These successive rejuvenations brought the original speed of 265 mph to about 365 mph or better. Armament has remained the same but, after the failure of the *Luftwaffe* to smash the Soviet Air Force during the summer of 1941 – an operation in which the Me-109E model was counted upon heavily, this fighter began to appear with protective armor plate for the first time. Recent reports from the Russian front indicate that the still newer Me-109G is in action, described as a high-altitude partly armored fighter plane with a Daimler-Benz 603 liquid-cooled engine of 1500-1600 hp, armed with three cannon and two machine guns. The Me-109 has probably reached its limit in the current model, but it still packs plenty of punch.

The year 1936 saw the advent of another famous fighter which was to make history, the Curtiss Hawk 75 (Army Air Corps P-36), powered by a Wright Cyclone 850-hp radial aircooled engine, which gave it a speed of slightly over 300 mph, somewhat faster than the Me-109 but slower than the Hurricane and Spitfire, all of the same vintage, and all but the P-36 using V-type liquid-cooled engines. The decided edge in speed which this latter type produced as against the aircooled radial, accentuated by racing records by souped-up models, helped to swing Air Corps procurement policy toward this type for the fighter planes

The one Army fighter which uses a radial aircooled engine, the Republic P-47, Thunderbolt, designed by Alexander Kartveli, can also trace a lineage back through the smaller P-43 or Lancer and more indirectly to the P-35. Improved cowling, external streamlining, a highly efficient system of ducts for air cooling and turbo-supercharger, have combined to make the Thunderbolt a speedy, powerful high-altitude fighter. The German Focke-Wulf 190, designed by Kurt Tank, draws many features from an early ancestor, the F.W.-159, first brought out in 1934-35. The F.W.-190 is powered with a B.M.W. 801 14-cyl, two-row aircooled radial engine of 1600 hp, and has a speed of about 375 mph, with good rate of climb. A newer version, powered by a BMW 802 engine of 2000 hp is coming into production and should prove to be a very tough customer. The Jap Zero also uses a 14-cyl radial of about 1000 hp, top speed about 340 mph. The British are standing pat on liquid-cooled engines for their fighters. The Bristol Beaufighter was powered originally with two Bristol Hercules 14-cyl radials of 1150 hp but, in the new Beaufighter Mark II, they switched to liquid-cooled Merlin XX's and greatly improved their speed, rate of climb, and service ceiling. The Army Air Forces is going ahead with developments of both liquid-cooled and aircooled types with horsepower considerably in excess of anything in production when this article was prepared.



Press Association photograph

Captured German Focke-Wulf F.W.-190 high-altitude fighter reconditioned for use by the RAF

Evolution of the Heavy Bomber

So much for fighters and their engines. The story on bombers is substantially the same. An outstanding example is the Boeing model 299, Air Corps B-17, or Flying Fortress. This was designed in 1934 as the world's first long-range four-engine heavy bomber, to be the keystone of an American striking air force. It was test-flown in 1936, and its development from that YB-17, adding supercharging for high-altitude operations, leak-proof gasoline tanks, heavy defensive fire-power from 0.50-calibre machine guns firing from all angles, and many of them from power-operated turrets, is a story full of examples of pioneering ingenuity. Its recent vindication abroad, after years of criticism, and equally amazing performance in the Pacific area as a tough customer both offensively and defensively, speak for themselves. The original engines were 850-hp Wright Cyclones, and these engines have been stepped up successively to 1250 hp, or a total of 5000 hp. Original speed was about 250 mph, with a gross weight of 20 tons; the present B-17F in production by Boeing, Douglas, and Vega has a top speed of over 315 mph and weighs more than 30 tons, fully loaded.

Another interesting case history is that of the Heinkel He-111K, one of the most widely used bombers of the *Luftwaffe*. In late 1935, some time before the sinister world-dominating designs of the Nazi party were apparent, a fast nicely streamlined 12-place "commercial" airliner known as the Heinkel 111 appeared and was placed in service with the *Lufthansa*. Not long afterwards, however, a faster version came out, equipped with two Daimler-Benz 600 engines of 650 hp (same engine as the original Me-109). With a speed of about 235 mph this airplane went into service with the *Luftwaffe* and was used in Spain. It was further stepped up with 800-hp engines, then Jumo 211's, then Daimler-Benz 601's of 1000 hp, and finally as the Heinkel 111K-5 with DB-601A's of 1150 hp. With these modifications of powerplant and other improvements, top speed went from around 200 mph to about 275; the original armament of three 7.7-mm machine guns (rifle calibre) has been doubled and a 23-mm shell cannon added, all manually operated – in fact the Germans have been very backward in their use of power-operated turrets. Hundreds of these bombers have been shot down, mostly over England. The He-111K has a service ceiling of 24,000 ft and a range of 2000 miles with a light bomb load. It is still widely used.

Up to the advent of the British four-engine heavies, the Stirling and Lancaster, one of the most consistently successful long-range bombers was the Vickers Wellington, "Whimpy" for short, and familiar in this country as the planes illustrated in "Target for Tonight," including "F for Freddie." The prototype appeared in 1936, first production job in late 1938, and by the middle of 1939, just before the kick-off of World War II, an RAF Bomber Command squadron received its equipment of Wellingtons, powered by Bristol Pegasus 9-cyl aircooled radials of 965 hp, speed 235 mph at 15,000 ft (critical altitude). Wicked looking gun turrets with two 0.303's in the tail and nose and one from cabin windows on each side provided good defensive armament. Range was about 1500 miles with a ton and a half of bombs. Construction feature: geodetic frame, fabric-covered, slow production but exceptionally sturdy. Wellington Mark II came out in early 1941 with two Rolls-Royce Merlin X's of 1150 hp, which improved speed, ceiling, range, and bomb load. The Mark III and IV are now in service, powered by two Bristol Hercules 14-cyl sleeve-valve aircooled radials of 1375 hp, and two P&W twin Wasps, respectively, which enable "Whimpy" to step up further its highly useful chore of dumping tons of bombs where they will do the most good.

No Substitute for Time

These examples of the development of fighters and bombers in Britain, the United States, and Germany are far from exhaustive and illustrate the immense value of having well-established designs ready before the shooting starts. If space permitted, another set of examples could be given indicating the time required before a brand-new design is ready to be put into full-scale production and combat operation. Two or three must suffice, briefly summarized. The Bell P-39 Airacobra was designed in 1937-38, prototype test flown spring of 1940, good production by the autumn of 1941, and thrown into action on various fronts during spring of 1942. The twin-engine P-38 or Lockheed Lightning was test-flown across the country in February, 1939, in about 7½ hr, hitting well over 400 mph at 20,000 ft while crossing the Alleghenies, with official NACA rating of 404 mph at 16,000 ft. However, it was thought to be too heavy (around 7 tons), and in all nearly 2000 changes were made down to the model P-38E, which was in good production from late 1941, and in action late spring 1942.

Both of these fighters, as well as the P-40 series, went through the usual sequence of prototype, exhaustive tests at Wright Field, award of contract for production in quantity, then tooling up at factory. The Martin B-26, Martian, fastest and most powerful of its type in the air, broke this tradition by tooling up first for quantity production, on the chance of success and a large contract. When the first B-26 flew in late November, 1940, it was a production model and several others were nearly ready. It is now well known that it landed a bit fast and there were other bugs to be ironed out. This ironing out has been done, at least a couple of years were saved, and now the Martian is doing its deadly damnedest on a dozen

Russian bomber which carried Molotov to England

fronts. Other planes are now coming along on this basis in this country. Britain's latest heavy bomber, the four-engine Avro Lancaster, has stepped up the tune across the water, with the admitted advantage, however, of development from the somewhat similar two-engine Manchester. (1936 design, 1940 service.) The Lancaster was designed by A. V. Roe & Co.'s Roy Chadwick in March, 1941; prototype test-flown September; first production job off the line December, 1941. This is the kind of stuff that will eventually gain overwhelming air superiority over the Axis on all fronts and prepare the way for final victory.

■ Looking at the Record

When all is said and done, however, the acid test of a military airplane is its record in combat. Do fighters knock off enemy fighters and bombers? Or do they get knocked off? Do bombers get through to their targets, drop their loads accurately, and get back to do it again, despite enemy fighter and anti-aircraft opposition? On the whole, so far in this war, the combat record of American planes has been good, and it is likely to get better shortly. Our heavy bombers, the Boeing Fortresses and Consolidated Liberators, have turned in amazing performances, and the new models B-17F and B-24E in large-scale pooled production have been further improved. Our medium bombers, Douglas Havocs, North American Mitchells, and Martin Martians, are highly praised for their speed, striking power, and high degree of invulnerability. As a matter of fact, except the practically untried Dornier Do-217E-2, powered by two BMW 802 18-cyl 2000-hp radials, there are no medium bombers anywhere to match them. The Havocs and Mitchells are powered by Wright 14-cyl Cyclones, 1700 hp, and the Martians by P&W Double Wasps of 2000 hp.

In the fighter class it may be admitted that for altitude work we have not yet been able to match the best fighters of Britain, Germany, and Japan, but the high flying P-38 and P-47 (aptly enough termed Lightning and Thunderbolt) wil soon be in wide-scale service, and on the basis of tests and operational reports to date should amply take care of things "upstairs." In the lower levels, where much of the fighting still takes place, our fast, well-armed and well-protected Airacobras and Warhawks are shooting down enemy planes on all fronts, in some areas on a better than 2-to-1 basis. The British are immensely pleased with the new North American Mustang (our P-51), which not only handles beautifully and is easy to service, but is said to outrun the speedy Spitfire at levels below 20,000 ft.

In the widely scattered theaters of operation, supply and service are vital considerations, and our rapidly expanding world-wide air line under the Air Transport Command, and maintenance set-up of the Air Service Command have become as important as any of the fighting outfits. The ability to eliminate bugs, and work in really essential battle-proved changes is a test for our American system of flexible-quantity production, avoiding the danger of Germany's original over-confident freezing of designs. There are indications that the Nazis have corrected this difficulty to some extent in that the F.W.-190 fighter and Do-217E-1 bomber have been in operation about a year with 1600-hp engines and are already about to be superseded by superior models using 2000-hp engines. These two airplanes may well prove to be serious contenders for a place in any list of the world's "best" planes, such as those recently picked by Peter Masefield, British aviation expert of the *London Sunday Times*. However, new American designs hinted at in the foregoing, and also British models, should be in operation as soon as are these *Luftwaffe* planes, and there is little doubt that the qualitative edge of United Nations' military aircraft will continue to be maintained. Already our side is ahead on a monthly production basis and this advantage will be increased in the near future.

Incidentally, in any selection of the "best" planes, the main point of this article should be kept in mind – a particular airplane is "best" suited for its designed purpose. Without a common yardstick, comparisons between planes are frequently unfair. To cite one example, in the heavy-bomber category it may be freely granted that the British Lancaster is "best" at the moment for very heavy night bombing of Germany, but any list that fails to take account of the amazing 'round-the-world record of the Boeing Fortress and Consolidated Liberator will hardly gain acceptance by a majority of aviation authorities.

No country has a corner on aeronautical developments, and the race for quality calls for research and still more research. Air power is today proving a decisive factor on many of the fighting fronts, and will eventually lead the way to victory. But victory alone is not enough. Peace and good-will are the only worthy goals, and here again air power can show the way.

British Information Services photograph

Four-engine Avro Lancaster, Britain's latest heavy bomber

War Transportation Meeting

(Continued from page 35)

Friend emphasized early in his presentation: "at least six engine manufacturers use such rings in production as original equipment, and these and many other manufacturers buy them and stock them for replacement service in their vehicles."

Plain non-expander type rings, he explained, lack the flexibility of the expander type to conform with worn cylinder-wall conditions in which the cylinder walls are no longer straight and round. To remedy these conditions, he said, is the principal function of the expander, or inner spring, which exerts independent pressure against the ring, forcing it to conform to variations in cylinder-wall contour within the area of ring travel. Expander-type rings provide flexibility and conformity through the correct combination of ring section radial thickness with expander pressures, he continued, compensating for worn cylinder conditions with negligible hindrance to cranking effort. Modern design of expander-type oil control rings combines moderate cylinder-wall radial pressures with ample drainage capacity through the ring to control oil consumption adequately. Ring and expander are designed as a unit to fit the piston-ring grooves properly. Then the correct ring design for each groove of the piston is assembled into a pack. Sufficient packs are placed in one package comprising an engineered set designated for a specific motor.

Concluding a detailed discussion of the reports of the members of Committee No. 5, which gave case histories of field experience demonstrating the capabilities of expander-type rings with different kinds of vehicles and under various operating conditions, Mr. Friend summarized:

1. They compensate for cylinder wear so that the time between engine reconditioning points is prolonged.

2. They increase the available service mileage from cylinder blocks by a very appreciable amount.

3. They allow the full usage of the block life, with fewer engine reconditioning periods, thus reducing boring expense, piston cost, and out-of-service time.

4. Expander-type piston rings of the segmental design reduce oil consumption, and practically eliminate clogging as a result of the independent action of the segments plus the wide drainage openings incorporated in their design. This design keeps the rings free to function for prolonged periods under rigorous operating conditions.

5. Expander-type rings, because of their longer effectiveness, prevent ring-sticking caused by over-oiling and blowby which, in turn, would cause oil oxidation and corrosion of bearing surfaces.

6. The overall indications are that expander-type rings may be used with equal success in either rebore or re-ring jobs. Since there is no functional advantage in using plain rings in any job, there is no need of carrying them in the inventory, thus eliminating duplication. Furthermore, the use of expander-type rings carries greater assurance of satisfactory performance.

"The report of Committee No. 5 clearly demonstrates that expander-type piston rings have a very definite function in the overall maintenance picture – that their use contributes materially to high maintenance efficiency," Mr. Friend concluded.

Warren A. Taussig, Chicago, quips with Emil P. Gohn (right), Philadelphia. Both are members of the SAE-ODT Coordinating Committee, which had met two nights before on administrative problems of the 30 subcommittees working on transportation and maintenance problems with the Office of Defense Transportation.

Discussion

To emphasize the value of expander-type piston rings and the research work on them reported in Mr. Friend's paper, Chairman Ray pointed out that such developments are particularly beneficial under today's shortages of manpower, equipment, and parts – since they show how to get more miles out of present equipment.

His sentiments were seconded heartily by M. E. Nuttila, Cities Service Oil Co., who specified that this work of SAE-ODT Committee No. 5 is of timely importance, particularly because:

1. It indicates how pistons can be conserved through elimination of frequent reboring operations.

2. It indicates the possibility of obtaining greater mileage in original rings through design improvements that provide adequate drainage.

3. It shows that it is possible to run engines satisfactorily to limits of cylinder wear previously considered "out of bounds."

Experience with a vehicle that had run 150,000 miles on steel segment expander-type rings after the original re-ringing job, has proved, he pointed out, that oil consumption, loss of compression, and loss of power, are not necessarily related directly. "Before proceeding with an overhaul," he advised, "be sure that you know how much loss of compression contributes to loss of power; there may be only half as much power loss as there is compression."

The next discusser, Donald K. Wilson, N. Y. Power and Light Corp., questioned Mr. Friend concerning cast-iron versus steel expander-type rings; expander rings in ventilated ring grooves; and ring gap standards of the different types. Mr. Friend replied that steel expander rings had been on the market only a short time and their advantages as compared with cast-iron expander rings were not well known. For example, he specified, with steel the steel segments can be made of smaller section; steel has about twice the elasticity of cast iron, permitting it to follow the cylinder walls more closely. What is being done with expander rings in ventilated ring grooves, he reported,

Chairman Herbert Happersberg of Metropolitan Section (right) chats with L. G. Kurtz, vice chairman for T&M of the Section, just before the semi-annual dinner, Oct. 7. The Section was host to the National Transportation & Maintenance Meeting.

P. E. Friend (left), chairman of SAE-ODT Committee No. 5, who presented the committee's report on Expander-Type Piston Rings to Prevent Excessive Cylinder Reconditioning. Don Wilson (center) and M. E. Nuttila are members of the SAE-ODT Coordinating Committee.

is to provide bridges to permit the slot to support the expander. Replying to Mr. Wilson's final question, he pointed out that, with the expander piston-ring design, gap standards are less important. The large gaps in some oversizes, he declared, seem to have no effect on consumption, calling attention to the overlap of the gaps in the various segments as one reason.

When to put the information reported in Mr. Friend's paper into effect was the problem of greatest concern to Ervin N. Hatch, American Brakeblok Division, American Brake Shoe and Foundry Co., the next to rise in discussion. "Mr. Friend has told us *how* to put it into effect," he said, "but I would like to know the right formula to tell me when to do it. Does it depend upon oil consumption, compression readings, or power loss?" In reply Mr. Friend told him that, although each operator usually selects his own base line or criterion for re-ringing and reboring, most of them use oil consumption as a base line. Chairman Ray contributed that, since Mr. Friend's paper was a progress report of continuing investigation, this point probably will be covered more completely later.

The effects of the individual driver and the type of the operation in the benefits to be derived from expander-type piston rings, were emphasized by John R. North, Commonwealth and Southern Corp. Explaining that his operation necessitated a lot of stops and starts like taxis and that his drivers varied widely in their habits, he revealed that, for this reason, wear and necessary overhauls in his operation vary over a wide range. As a result, he explained, the mileages reported in Mr. Friend's paper are not obtained and cannot be expected in this service.

Replying to several questions put by Mr. North, Mr. Friend reported that a record of gasoline consumption was kept by months and that it showed a gradual increase in miles per gallon. He added that a 5% decrease in net horsepower and loss of torque can be caused by drying up the top ring. Top grooves are cut out and should be, he continued in answer to Mr. North's second question, adding that in some cases the groove is filled in by building up with spray metal and then cut in again. When 1/32 in. is cut off the ring, he explained, although a wider ring can be used, the same size ring with a spacer is preferred as it does not add to the mass of the ring.

Replying to the question of Warren A. Taussig, Burlington Transportation Co., Mr. Friend explained that, although the recommendations for use of expander rings vary somewhat among piston-ring manufacturers, a typical piston has two plain compression rings at the top under which is an expander-type compression ring designed to permit oil to be carried to the top two rings. Below these three rings is another expander compression ring and an expander oil ring.

The growing problem of mechanic shortage was introduced into the discussion by the next discusser, S. G. Page, Equitable Auto Co., who proposed doing something about it. "We should be writing basic manuals," he urged, "to be passed on to the green men who are taking the places of our experienced maintenance men."

"Steel expander oil rings dominate the picture," declared Austin M. Wolf, automotive consultant, the next discusser. He pointed out that they are not subject to the vibration of cast-iron rings which may run into the natural frequency of the rings and break them, and that their draining ability is at a maximum. Since there is no such thing as a round cylinder, he continued, their ability to compensate for distortion is a big advantage. Citing research employing polar diagrams to back his views, he opined that the deterioration of expander rings in service should be less than indicated in Mr. Friend's paper.

In a concluding summary, Mr. Friend brought out that the discussion had given the committee some new ideas on how to go ahead in its work. As the data come in, he reported, the reactions of the various fleet operators have proved to be largely corroborative. Speaking of the type of service data needed by the committee, he stressed especially the need for information on four-cycle diesel engines.

A piston-ring exhibit, showing what the engine and vehicle manufacturers are using and recommending for service and original equipment, drew an interested crowd immediately following adjournment of the session.

Standard Practice Instructions – J. WILLARD LORD, Atlantic Refining Co., and Chairman, SAE-ODT Committee No. 17.

IN presenting a plan for standardized maintenance and repair instruction cards, approved by the SAE as a recommended standard practice, Mr. Lord said his Committee has hewn through a jungle of conflicting methods of disseminating instructions to automotive mechanics.

Briefly, the system consists of a number of large cards, each to be printed and distributed to garages and repair shops by the respective equipment manufacturers adopting the scheme. These are to be indexed by types of equipment and specific products, and filed in the shop tool room or other place convenient for all mechanics.

Illustrated with photographs and drawings, written in simple language, and printed in large type, the system will include instructions for the maintenance of each make of vehicle, each component part subject to repair, and special tools.

The cards will be 14 x 18 in., and finished with greaseproof coating. Both sides of the card may be used for instructions if needed.

This system, the Committee reported, will make it possible for the mechanic to take his specific instructions to the vehicle, and thus be guided in each step of the repair job at hand. A wide survey of bound, looseleaf, and separate card instructions used by the industry was undertaken to guide the Committee in its work, Mr. Lord reported. A number of automotive and equipment manufacturers and petroleum refiners have found by experience that the single-card instruction plan has every advantage over bound instructions, he said.

The Standard Practice Instruction format and scheme is offered for the voluntary adoption of all vehicle, engine, component parts, accessory, and tool manufacturers, and has been accepted by the Office of Defense Transportation as the most practical method devised to help train mechanics and repairmen to conserve materials, parts, and vehicles during this emergency.

Discussion

"Never has the problem of automotive maintenance been more important than during the present emergency," admitted D. H. Green, National Carbon Co., Inc., in the discussion which followed Mr. Lord's paper. "It behooves all of the industry to make an extra special effort toward motor-vehicle conservation," he said. In view of this fact, he explained that his company is planning to exploit the possibilities of the SAE Standard Instructions Card by printing copies for experimental distribution in civilian and military motor transport training

and service organizations. Reactions from the field will be the basis of revisions.

Walter A. Roberts, Educational Consultant, Washington, showed further the need of simplified instructions when he stressed the point that a great many old-time mechanics and maintenance men work from practice and habit rather than from a thorough knowledge and background, of their job. Ineffectiveness of instructions books often can be traced to the book itself because – although the words are there and can be read – the reasoning is too hard for the practical mechanic to follow. What we need in the maintenance field, he said, are simple instructions that are easily understood, with accompanying pictures.

One obstacle in the way of a program of this type, pointed out Franklin A. Miller, U. S. Asbestos Division of Raybestos-Manhattan, Inc., and representative for the National Standard Parts Association, is the parts designer's weakness to spend his dollars in advertising the part rather than in showing how to use the part properly. He admitted that it would be a benefit for the industry if more money were put into instructions for use rather than in exploitation of the product.

Standard practice instructions are valuable, Albert H. Eichholz, Motor & Equipment Manufacturers Association, declared. Although first attempts at instructions will probably be crude, he feels, they will be down the right alley. When competition among parts makers enters the picture, the manufacturer will strive for better instruction sheets than his competitor, with the result that the maintenance man will profit by better printed matter and illustrations.

That the "forgotten maintenance man" will at long last get a much needed break when instructions are improved and given to him in a workable manner, was expressed by SAE Vice President Jean Y. Ray, Virginia Electric & Power Co.

Metal Coating of Automotive Parts – H. S. INGHAM and JOHN E. WAKEFIELD, Metallizing Engineering Co., Inc.

(Progress Report of SAE-ODT Committee No. 6 which includes research on some new applications.)

USED successfully and economically for salvaging worn automotive parts for several years, the process of metallizing presents possibilities today, when purely economic considerations have given way to wartime necessity, that are far beyond those of normal times, these authors pointed out in the first part of their paper, presented by Mr. Wakefield.

The purpose of their paper, they announced, is to explain what the metallizing process is; what equipment is necessary; to describe established applications, including the methods used; and to suggest newer and greater possibilities. They went on to explain with the aid of illustrations the actual mechanics of metal spraying – including the principle of mechanical anchorage and how it should be provided; how a coating is built up; and what the resulting characteristics are.

"Preparation is the biggest single factor in the success of any metallizing application and its importance cannot be overstressed," they emphasized in a discussion of preparatory methods. They also stressed the amount and type of equipment necessary for good metallizing work by describing essential items.

New SAE Maintenance Instruction Forms Explained

The standardized forms for presentation of maintenance and repair material for use of mechanics while actually working on repair jobs – which recently were approved as an SAE Recommended Practice – aroused widespread interest among representatives of parts companies and associations attending the SAE War Transportation Meeting.

A representative group of these men listened to J. Willard Lord, chairman of the SAE-ODT committee which developed the standard forms, present the story behind the development, as well as the details of the forms themselves, in a paper on the second day of the meeting. Following that presentation, Mr. Lord met informally with these visitors to answer further questions.

Resulting from that informal gathering come requests for a brief, written explanation of the recommended standard practice forms, suitable for distribution at cost to manufacturers or groups that might be interested in exploring further possibilities of utilizing them in the preparation of future maintenance instructions. The SAE is in the process of developing a brief summary to meet those requests.

Considerable actual field experience was then reported, including numerous examples of the four most widely accepted types of work: crankshafts, cracked heads, water-pump shafts, and transmission cases. Possibilities suggested by versatility of the process and the unusual characteristics of the sprayed metals were brought forward for inspection.

Comparing advantages and disadvantages, they brought out that, on the one hand, metallizing tends to absorb oil due to its open-grain or porous structure, resulting in a reduction in operating friction of from 20 to 25%; and that its mechanical anchorage makes it possible to build up a coating of hard steel onto a soft steel shaft or other part. On the other hand, they continued, its disadvantages are a reduction in tensile strength and a comparatively low bond strength.

"The metallizing process does offer," they summarized concluding the first part of their paper, "a solution to problems which cannot be solved in any other way now known, and it holds the hope of reclamation of automotive parts even though the metals situation becomes blacker than anything we have seen yet."

In the second part of the paper, Mr. Ingham announced and described a new method of surface preparation – the "fuse-bond" method – which, he contended, "is entirely different from common practices" and which "promises to revolutionize many metallizing applications and to open up many more which heretofore have been impossible."

Mr. Ingham qualified, however, that the method has not, as yet, had time to prove its worth completely, and that there are as yet no machines available for immediate commercial use. He revealed that the bonding method itself and equipment used are protected by patents pending, and that "Fuse-Bond" is a trademark of the Metallizing Engineering Co.

The "fuse-bond" method of preparing surfaces for metal spraying, he explained, consists essentially of electrically fusing and bonding metal from an electrode onto the surface to be prepared. This metal is bonded or welded to the surface and forms a metal froth or foam which presents a great number of holes and interlocks to which the sprayed metal may be bonded. The method differs from welding in that the metal is deposited by actual contact of the electrodes with the work, and not by striking an arc.

After discussing the theory of the method, describing the equipment and giving test results, Mr. Ingham emphasized the following points in conclusion:

1. The fuse-bond method will augment, not displace, other methods of bonding sprayed metal.
2. In special cases on machine element work, the method *can* be used to replace all other methods.
3. The cost of many jobs requiring special machining, such as regrooving, will be reduced by this method.
4. The method sometimes will be used in combination with other methods, such as blasting.
5. The method will be used on jobs that are now considered "tough," such as flat surfaces, and on many jobs that are not now practical, such as on inside diameters, valve seats, and so on.

Discussion

Intent on absorbing every possible detail that will enable them to extend the life of automotive parts, T&M men peppered Mr. Wakefield with questions in the discussion of the first part of the authors' paper. The questioners included T. C. Smith, American Telephone & Telegraph Co.; Lawrence W. Fischer, Timken-Detroit Axle Co.; Henry M. Atwood, Metallizing Co. of America; Warren A. Taussig, Burlington Transportation Co.; J. P. Stewart, Socony-Vacuum Oil Co., Inc., and many others.

In this discussion the following information was brought out:

- The gun should be held from 4 to 10 in. from the part being coated.
- Parts being metallized are seldom heated over 200 F.
- Tensile strength of metallized bearings is between 15,000 and 20,000 psi.
- It is safe from a strength standpoint to cut down the size of most parts 1/16 in. before metallizing.
- According to a recent report the torsional fatigue strength of metallized parts is greater than that of comparable parts that have not been metallized.
- Magnesium can be sprayed in the metallizing process by preheating this material.
- In metallizing crankshafts, they should be centered on throw centers – not by V-blocks, to avoid eccentricity, and an adequate thickness of metal should be sprayed on – usually about 0.100 in. on the diameter. With either an eccentricity of 0.040 or

turn to page 62

Aircraft Production Meeting. Oct. 1-3

(Continued from page 37)

ity or reliability. Aeronautical art will advance, he said, with every improvement in the art of flight testing.

***Intercoolers and Their Performance in Aircraft* – S. K. ANDERSON and P. A. SCHERER, AiResearch Mfg. Co. (Presented by Mr. Scherer).**

INTERCOOLERS, said Mr. Scherer in opening his reading of the paper, are like the "Old Woman Who Lived In the Shoe," they have so many parameters it is hard to tell what to do. To an imposing list of heat-transfer symbols are added those of aerodynamics. Since the supercharger intercooler is a necessity for military equipment, and there are gaps in the engineering knowledge, further basic studies must be made, but military restrictions will undoubtedly conceal much of the information so compiled. The race for altitude has posed so many intercooler problems, design is only a pace ahead of production. Since the selection of an intercooler may hinge on the space available for it, he cautioned that every care should be used to obtain the maximum possible ram at the suction of the supercharger with the corresponding decrease in load on the intercooler. And, in designing faster ships, engineers should be sure that the critical intercooler condition may not exist in level flight rather than in climb. One thing seems clear, he said, and that is that no governmental ceiling will be placed on altitude; and the demand will be active.

AIRFRAMES PRODUCTION TECHNIQUE SESSION

J. L. Atwood, *Chairman*

Simultaneously with the Flight Testing Session, another on Airframes Production Technique was held in the Biltmore Ballroom, at which two papers were presented that were of particular interest in these wartime days of steadily increasing demands for greater speed and quantity, and conservation of critical tools, machines and materials.

***Technical Developments in High Production Sheet Metal Forming* – WILLIAM SCHROEDER and T. H. HAZLETT, Lockheed Aircraft Corp. (Presented by Mr. Schroeder).**

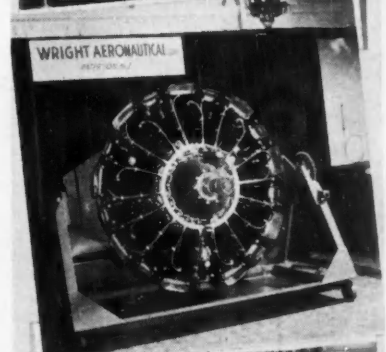
THE paper dealt particularly with those phases of aircraft production concerned with sheet metal forming, viz., basic analyses of sheet metal forming operations, classification of parts into basically similar groups, forming techniques, and limits to which the commonest materials may be successfully formed. Emphasis was placed upon the need for quantitative knowledge of the forming limits for die and aircraft design.

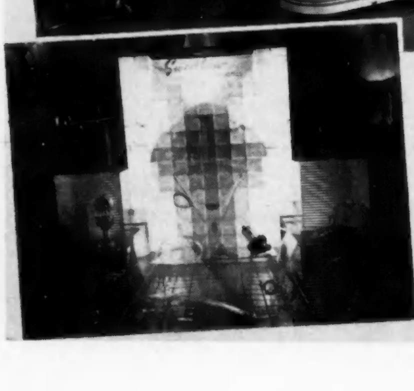
All of the common types of forming equipment, with their applications and limitations, were discussed. Methods capable of high rates of production, such as the rubber pressure hydro-press and the double acting press, were discussed in more detail. Forming limits were presented and techniques were discussed for flanging, stretching, drawing and redrawing.

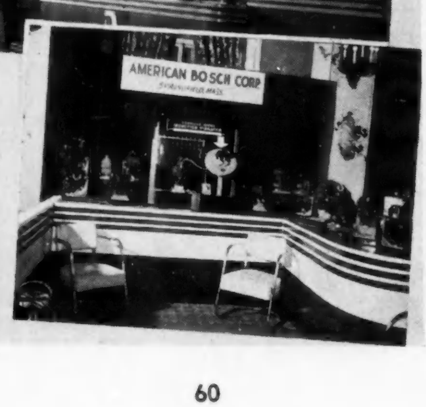
***Impact Extrusion and Cold Pressing of Airplane Parts* – PHIL KOENIG, Consolidated Aircraft Corp.**

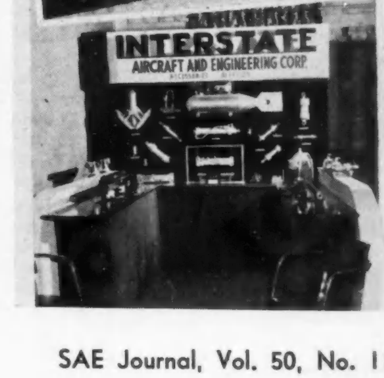
DEVELOPMENTS resulting from research inspired by the war's demands for greater speed, larger volume and material and labor conservation, have led to the manufacture of many airplane parts by the impact-extrusion method. Where the previous methods called for casting, forging, or machining from solid stock, research has developed ways to use the impact-extrusion method that are more rapid and economical. Aluminum and aluminum alloys can be extruded by this method and their size is limited only by the power of the press available for the work. Small parts are produced in large quantities by the use of multiple dies. Experiments have established the pressures required to form these materials by the

Occupying the 26 booths which constituted the SAE Aircraft Engineering Display, at the SAE National Aircraft Production Meeting, Los Angeles, were the following: Aeroquip Corp., detachable fittings and self-sealing couplings; Swedlow Aeroplastics Corp., turret, nose and tail plastic parts; American Bosch Corp., magnetos; Parker Appliance Co., composition fittings; Ducommun Metals & Supply Co., precision gages; Rohm & Haas Co., Inc., plastic assemblies; Tinnerman Products, Inc., speed nuts, clamps, clips, assembly rings, pulleys, and brackets; Interstate Aircraft & Engineering Corp., hydraulic cylinders, bombs, machine guns; Simmonds Aerocessories, Inc., controls, clips and fasteners; Wright Aeronautical Corp., radial air-cooled engines; Cleveland Pneumatic Tool Co., Aerol struts, Cleco fasteners; Ryan Aeronautical Co., exhaust manifolds; Kelite Products, Inc., cleaning and processing materials; Magnaflux Corp., inspection method demonstration; International Nickel Co., Inco alloys; Lord Manufacturing Co., bonded rubber mountings; Pacific Airmax Corp., comfortization equipment; Oakite Products, Inc., cleaning materials; Adel Precision Products Corp., clamps, clips, control valves, filters, hand pumps; Harrison Radiator Division, GMC; Turco Products, Inc., cleaning materials; National Screw & Manufacturing Co., screws, AN bolts, studs, AN nuts, Phillips recessed products; and Purolator Products, Inc., hydraulic controls and instruments featuring micron filtration.









impact-extrusion method, complicated designs and shapes can be easily produced, and there seems to be no limit to the height to which the metal will flow, if the required force is applied to the tools.

ENGINES AND AIRPLANES SESSION

Arthur E. Raymond, Chairman

Approximately 400 attended the first night session of the three-day conference and heard two papers, one on new U. S. methods, and one covering findings of a study of a Japanese Mitsubishi Kinsei engine, and viewed a technicolor film produced by the Bell Aircraft Co. to explain to laymen how that firm builds the Airacobra.

How Vultee Uses Master Layout for Production – S. R. CARPENTER, Vultee Aircraft, Inc., Vultee Field Division.

MASTER layout as known at Vultee is a complete and accurately scaled, full size drawing on metal sheet showing all information required for jigging and tooling of assemblies, the Carpenter paper explained. For the method Mr. Carpenter claimed originality only for some of its short-cuts. Its value, he stated, is in supplying production parts to the assembly line with accumulative error, due to the human element, minimized. The system he described as an extension of the lofting art that provides for production applications which do much to cut down the interval between the time of drawing the first line and completion of tooling. Savings in time have been substantial and are estimated as follows: Template department, 30%; plaster shop, 5%; jig department, 15%; and tool design, 20%. The figures are said to be conservative.

Some Notes on Design Features of the Mitsubishi Kinsei Engine – W. G. OVENS, Wright Aeronautical Corp.

THIS paper, well illustrated with slides from photographs of the only engine available for study, and that a damaged one, did not attempt to completely cover the subject, but did give enough to fulfill the speaker's summation, that this particular Jap engine was a very good, although not exceptional powerplant. (This paper was printed in full in the July 1942 SAE Journal.)

AIRCRAFT WELDING SESSION

Peter Altman, Chairman

The first paper scheduled for this session was cancelled for reasons of military secrecy. It was to have covered "Flash Welding – Aircraft Quality" and had been prepared by W. D. Harrison of the Douglas Aircraft Co. The time allotted for it was later used to show a sound film, produced by the Hamilton Standard Propellers, Division United Aircraft Corp.

The Place and Use of Spot Welding in Design and Production of Aircraft – G. S. MIKHALAPOV, National Research Council.

AFTER pointing briefly to the advantages and wide use of spot welding, this paper listed airframes as a very large exception to the otherwise almost universal adoption of the method for joining sheet metal. To analyze and explain the underlying reasons for this exception was the stated purpose of the paper. That it did, by discussing materials which, because they were difficult to weld, retarded adoption by airframe manufacturers; by discussing the quantity problems involved in its general adoption, structural requirement hurdles that have to be cleared, its present uses in aircraft, selection of parts best suited for the method, and process control requirements. The paper concluded with the assurance that if the recommendations of the Aircraft Welding Standards Committee are followed, manufacturers need have little fear of the quality of the work and will obtain excellent economy results.

AIRFRAMES PRODUCTION SESSION

J. M. Gwinn, Jr., Chairman

This session featured the presentation of two papers on two vitally important problems now faced by the aircraft industry. One discussed ways and means of circumventing shortages of so-called critical materials, and the other on template duplication.

Non-Critical Materials for Airframe Construction – L. D. BONHAM, Lockheed Aircraft Corp.

IN opening his discussion, Mr. Bonham explained that the terms "critical" and "non-critical" should not be confused with similar terms used by the military, and that a clearer title would substitute "Less" for "Non," as most materials used in aircraft are critical to varying degrees. The paper then discussed standardization to conserve materials, conversion to less critical materials, available steels, aluminum alloys, copper, plating materials, plastics, finishing materials, rubber elimination in airframes, wood and plywood, and insulating material substitution problems. The speaker summed up his case by saying that every engineer responsible for the design of any item in the airplane must realize how extremely important it is to utilize materials of a less critical nature wherever possible. If good judgment is used, and sound selections are made, the combined efforts will pay huge dividends by the size of their contribution to the supreme effort that has to be made to win this war.

Templet Duplication by Dry Offset Printing – W. A. COLLINS and J. T. BARNES, Curtiss-Wright Corp., Airplane Division, Columbus Plant. (Presented by R. C. Blaylock, Curtiss-Wright Corp.)

THE dry offset printing method of templet duplication was adopted by Curtiss-Wright, these authors pointed out, as a solution to the problem of furnishing complete integrated plants or subcontractors' plants with information complete enough to insure a reasonable degree of interchangeability and replaceability of parts among manufacturers. To achieve this goal, they explained, a method of rapidly reproducing mold loft templets complete with coordinating hole locations, including some mechanical means of eliminating repetitive work, was a necessity.

The dry offset printing method, they continued, offered the advantage of simplicity, and was the only method investigated whereby the holes in the duplicate templets could be drilled from the original templet or layout.

The original idea for the method came from a pamphlet describing a templet production method developed by Westland Aircraft, Ltd., of England, employing printer's ink and a homemade jackscrew press. The pamphlet was forwarded by the Production Engineering Office of the Navy Department.

In the dry offset printing process, they explained, a film of ink is transferred from a plate which is an original templet layout, to a rubber blanket and, from the blanket the ink design is offset or transferred to the printing stock. In basic experiments performed in a commercial printing shop, they reported that scribed lines of the templet could be reproduced with a constant accuracy of ±0.005 in. for all normal sized templets, and the printed lines were found to be slightly finer than those of the original templet.

After going on to describe the method and its equipment in considerable detail, the authors concluded that:

"The development of templet duplication by the dry offset printing process has pointed the way to a tremendous reduction in the time required to reproduce the thousands of duplicate templets required for a major production problem in which interchangeability of parts and assembly throughout a product having world-wide distribution is required."

GENERAL SESSION

A. T. Colwell, Chairman

Although planned for those in attendance at the SAE National Aircraft Production Meeting, this session produced the industry's public refutation, by some of its engineering authorities, of the current public criticisms of U. S. aircraft. All of the four who spoke submitted proof of U. S. aircraft excellence and those whose papers preceded and followed them on the three-day program gave ample evidence that these superior aircraft are being steadily improved. That the general session's refutation was authoritative is best indicated by the industrial titles which follow the names of the session's speakers: A. T. Colwell, Vice President, Thompson Aircraft Products Co., and past president of SAE; Col. J. H. Jouett, President, Aeronautical Chamber of Commerce of America, Inc.; Thomas Wolfe, Vice President in charge of Traffic and Advertising, Western Air Lines, and representing Air Transport Association of America; A. W. Herrington, President of SAE, and Tye M. Lett, Jr., Overseas Representative of the Allison Division of General Motors.

President Herrington, after pointing out the detrimental effects of the unfounded current criticism of U. S. planes, called attention to the battle records they are making possible, and gave much of the credit for them to the standardization accomplished by the SAE groups which have been working on it throughout the 37 years since the organization's founding.

President Jouett of the Aeronautical Chamber of Commerce submitted figures to prove that U. S. aircraft are out-fighting their opponents and likewise gave much of the credit for their box scores to the maintenance problems standardization has solved.

Mr. Wolfe cited the excellence of U. S. transport aircraft, as proved by the tremendous war job being successfully accomplished by the members of the Air Transport Association.

Mr. Lett, the final speaker on the program, gave dramatic and factual proof of the evening's theme, when he told of the work of the AVG's ground crews. Popular opinion, gained from news accounts, that the AVG was equipped with inferior, obsolete aircraft, is incorrect, he said. The planes they flew were current models of the period in which the AVG was organized and they outperformed even still later models the Japanese threw at them toward the end of the AVG's record-breaking, but short existence. Measured against current U. S. planes, produced two years later, the fighters of the AVG are outmoded, he said, but that is no reflection on AVG planes.

AIRCRAFT MATERIALS FINAL BUSINESS SESSION

H. D. Hoekstra, Chairman

Two papers on the all-important subject of new materials for aircraft production were delivered at this session. Both papers covered the new methods that have been developed for return to wood in the construction of aircraft.

Wood-Plastics in Mass Production of Aircraft – CURTIS L. BATES and HAROLD J. BLACK, both formerly of the Plxweve Manufacturing Co. (Presented by Mr. Bates).

AFTER briefly reviewing the history of the use of wood in aircraft, the paper covered such points as: strength-weight ratios, panel stiffness, ease of working, abundance of supply, fire hazards, vibration characteristics, chemical and salt water resistance characteristics, short assembly time, and went into the subject of designing for conversion to wood. Its conclusion was that wood, suitably reinforced by plastic substances, has many desirable characteristics as an aircraft material but that wood plastics should be looked upon as a fundamental structural material, not as a second-best substitute.

***New Applications of Panelyte in the Aircraft Industry* – C. R. MAHANEY, Panelyte Division, St. Regis Paper Co.**

MR. MAHANEY'S paper was built around the central theme that Panelyte is a satisfactory substitute for materials heretofore used by which, because of their scarcity, can and must be replaced in aircraft construction. It discussed flooring, skin, panel, stabilizer, door, fairing, table, stowage box, instrument panel, pulley, tank, housing, baffle, fabricated parts and large structural molding uses of the product. The paper's conclusion was that this product has now emerged as a substitute material that has become a permanent material in aircraft construction.

No session was held on Saturday afternoon, but that evening as many of the 1600 who registered for the meeting as could be accommodated attended the banquet and ball which brought the sessions to a close. Opinions expressed by those in attendance were unanimous that, despite the restrictions imposed by military necessity, the meeting provided those in attendance with much new and valuable information.

Adjacent to the ballroom in which most of the sessions were held, a large connecting room provided space for 26 booths in which leading manufacturers of tools, equipment, parts, and supplies presented the new items in their lines. The booths drew large numbers, especially before and after the several sessions, and representatives at the booths reported inquiries indicated serious interest in the information available there.

Meeting Sponsorship

The three-day meeting was sponsored by the SAE and its four Pacific Coast Sections, with the cooperation of the Aeronautical Chamber of Commerce of America and the Air Transport Association of America.

A. E. Raymond, of Douglas Aircraft Co., Inc., was the general chairman of the meeting. J. H. Kindelberger, of North American Aviation, Inc., was chairman of the Aircraft-Engineering Display Committee. On SAE President Herrington's staff were Peter Altman, Vultee Aircraft, Inc., the SAE Aircraft Vice President, and C. F. Bachle, Continental Aviation and Engineering Corp., the SAE Aircraft-Engine Vice President. Representing the SAE home office were John A. C. Warner, General Manager, C. B. Whittelsey, and James Redding. Representing the Pacific Coast sections were Chairman Foster M. Gruber, Douglas Aircraft Co., Inc., and Vice Chairman George Tharratt, Adel Precision Products Corp., of the Southern California Section; Chairman F. W. Twining, Twining Laboratories, Northern California Section; Chairman J. R. Kessler, Oregon Parts Co., Oregon Section; and Chairman Lt. Kenneth A. Ayers, Director of Maintenance, 13th Naval District, USN, Seattle, of the Northwest Section.

War Transportation Meeting

(Concluded from page 59)

0.050 in. or greater, or too thin a shell of metal, or both, the metallized shells are likely to break away and become loose.

- Experience indicates that, regardless of the type of bearings employed, metallized crankshafts last longer than the originals.
- Hardness of a coated surface is very hard to measure because of its open-grained nature. Indications of hardness testers are lower than a file test will show for this reason. However, wear resistance is the property with which the maintenance engineer is primarily concerned – not hardness *per se*.
- Parts metallized with 80-carbon steel cannot be machined; they must be ground.
- Exhaustive tests in England comparing shafts and bearings before and after metallizing indicate that the metallized parts will run with less friction, under heavier loads, and for a longer time, than regular hardened bearings and shafts.
- Lands between piston rings have been metallized by the use of special tools.
- Heat transfer of metallized parts is slightly lower than equivalent uncoated parts, depending upon the thickness of the metal coating and metal used.
- Metallized parts will not stand a great deal of distortion, depending again on the thickness and the metal in the coating. However, present indications are that parts prepared for metal coating by the fuse-bond method will stand more distortion than other metallized products in most cases.

Revolutionary new applications of metallizing – in building up worn brake drums and valves – through the use of the "fuse-bond" preparatory method of metallizing were presaged in discussion of Mr. Ingham's concluding part of the paper.

"Metallizing is entirely feasible and possible on small drums," concluded Sidney G. Tilden, S. G. Tilden, Inc., after reporting preliminary results of tests on brake drums to determine the friction characteristics of the coated surface and the strength of the bond. "To metallize large drums," he continued, "requires large boring mills or heavy machine tools probably not available today."

He emphasized that all brake drums were prepared for metallizing by the fuse-bond method. Several metallized drums already have run over 4000 miles, he said, and seem to work fine with no apparent difference in braking.

Troubles centered around machining the drums, he pointed out; it has proved difficult to machine them on even the best brake-drum equipment. Spindle speeds of this equipment are too high and, as a result, tools burn up rapidly, he said, adding that he had been able to reduce these speeds somewhat.

A preliminary report of work being done in metallizing worn exhaust valves using the fuse-bond method of preparation, by Thompson Products, Inc., was given in a letter read to the session.

Used valves and valve seats removed from engines in the field for valve replacement are being fuse-bonded, metallized, machined and tested, the letter explained, declaring that the tests are not far enough along to justify any conclusions.

The question of M. E. Nuttila, Cities Service Oil Co., whether metallizing can be applied to repair a crack extending from the valve port into the cylinder bore drew two opposing answers. Mr. Wakefield did not recommend the application unless fuse-bond can be employed, giving as his reason that coatings do not usually stand much impact, whereas Henry M. Atwood, Metallizing Co. of America, reported that his company has had a number of successful applications of metallizing the cylinder block across the valve seat. Mr. Atwood also described work being carried on in the application of metallizing to increase corrosion resistance, such as "aluminizing" airplane cylinders. This treatment, he pointed out, provides resistance both to heat corrosion and salt-water corrosion. Some pistons can be sprayed with copper on the inside surface, thereby effecting better heat transfer with the oil. He announced that tests are now under way with the aircraft companies to improve heat transfer in aircraft cylinders by this method.

"I have been sold on this idea for years," declared W. J. Cumming, Office of Defense Transportation, to summarize the discussion. He told how he had started in to reclaim shafts and crankshafts by metallizing in 1929 when there existed a similar dearth of replacement parts. "One important advantage," he emphasized in conclusion, "is that bearings and shafts can be kept standard, without the necessity for a lot of odd sizes."

Round Misquoted on Crankcase Draining

On page 24 of the report of th. recent SAE West Coast T&M Conference published in the October, 1942, issue of the SAE Journal, George A. Round, Army consultant on fuels and lubricants, was quoted incorrectly as saying, on the subject of crankcase draining:

"On the desert, the Army drains crankcases every 6000 miles; drains when hot and fills with cold oil; use of mixed oils results in same results as are to be had from each kind itself – no indication of adverse results from mixing . . ."

The actual facts, as reported by Mr. Round at this meeting, are as follows:

Transport vehicles operating on the highway at desert temperatures have engine crankcases drained every 2000 miles. Gear cases are normally drained every 6000 miles. Under bad dust conditions off the highway, crankcases may be drained every 200 miles or even every day. No adverse effects have resulted from mixing different brands of engine oil meeting Army Specification 2-104. The Army hasn't mixed gear oils but would not anticipate trouble from doing so.

SAE War Engineering Board Expands Efforts as Military Demands Grow

THE SAE War Engineering Board has grown in stature to one of the foremost groups of consulting engineers on problems of design and material conservation in motorized equipment. The scope of its projects includes the tanks, combat and motor transport vehicles of the Ordnance Department and civilian cars and trucks under the jurisdiction of the War Production Board.

Through the War Engineering Board cooperation between industry and the Armed Services has become more effective. Frequent expressions of commendation from high ranking Army officers and WPB executives have been received in appreciation for valuable engineering service rendered. From the standpoint of experience and ability, the WEB occupies the position of a court of last appeal on automotive engineering matters.

Under the chairmanship of J. C. Zeder, chief engineer of Chrysler Corp., the War Engineering Board has continued to expand its activities, working through some 26 committees with more than 300 members under directives from Ordnance, Signal Corps, the Navy and the WPB.

Progress reports, and definite recommendations resulting from many days and long hours of effort on the part of committeemen and bearing the stamp of approval of the WEB have covered such a wide variety of knotty problems as: the starting and operation of vehicles in temperatures of —40 F; substitution for rubber in storage battery cases; reduction of nickel and chromium in exhaust valves; reduction of rubber in tanks; effect of extreme temperatures on electrical equipment; clutch facings; interim emergency tires for civilian use, and many others.

In two instances the WEB has been asked to suggest revisions for WPB Limitation Orders. One was the Copper Limitation Order 1-106; the other the revised Limitation Order L-128 covering exhaust valves. In another instance a WEB committee wrote the specification for a new hydraulic brake fluid.

Many directives affecting marked reductions in the use of critical materials, which have helped to avert bottlenecks and have forestalled the closing of defense plants have been issued as a result of the recommendations of the War Engineering Board.

Axis and Allied Planes Compared

▪ *Metropolitan*

The appearance of a plane at a fighting front represents on the average of three to five years of continuous, unrelenting labor-design, test flying, structural changes decreed as a result of the test flights, and tooling for production. This, according to Major Nathaniel F. Silsbee, chief, Information and Education Division, Public Relations Office, Army Air Corps, is the record of every belligerent, and as yet there have been but one or two instances where quicker results have been achieved satisfactorily.

The occasion of the speech by Major Silsbee was the first meeting of the current season for the Metropolitan Section, an event also marked by the use of new quarters, the Hotel Edison. Particularly gratifying was the large number of dinner guests, over 600, who came to participate in the program planned by Kenneth Campbell, vice chairman for aeronautics.

Major Silsbee's paper appears in full beginning on page 49 of this issue.

Following the main paper, Major E. C. Locke, chief, Aircraft Identification Division, presented a verbal and pictorial description of some enemy aircraft, principally the Jap Zero and Mitsubishi 97 planes.

The Major, who spent four months in England during the past summer enlarging and perfecting the art of aircraft recognition, stated that the Germans have but one plane, the little-known Focke-Wulfe 200 commerce raider, capable of engaging in bombing operations against the continental United States.

Major Locke also made available a sound picture which he secured from the British Ministry of Information. Entitled "Sky-Borne Troops," the fourth in a series called "Know Your Enemy," the movie showed the training, equipment, and attack methods used by the German para-trooper. One significant thing stood out – the attackers are extremely helpless in the air and for the first few moments after landing. Disable them before they can secure the arms dropped separately, also by parachute, and the planned invasion collapses, the picture indicated.

T. P. Wright, deputy director of the Aircraft Production Branch of WPB, then spoke about some of the problems confronting plane manufacture in this country. We can't simplify any more than we have. We have a total of 29 planes of all types required by the Army, 21 by the Navy. With any lesser number, we could not successfully train our flying personnel, provision and equip their wide-flung bases, or perform effectively at the fighting fronts.

Said Mr. Wright, "Our planes are second to none, despite what we see in the press to the contrary. Each of our planes is doing well that duty for which it was designed. Our ratio of losses on all fronts, compared with the losses of the enemy, is in the order of 1 to 4."

A film in technicolor, presented through the courtesy of Alec Burton, Washington representative of North American Aviation Co., showing the latest planes manufactured by the company, completed the program for the meeting.

turn to page 81

The Army Air Forces

(*Concluded from page 25*)

subcontracting, will have a lot to do with the winning of this war. With tens of billions of dollars worth of rush orders, new methods can be used to the common advantage. We are pooling our resources for the quantity production in several widely scattered factories of the latest and improved models of the B-17 and B-24 heavy bombers. Assembly line techniques, ingenious short-cuts, improved processes are slashing thousands of man-hours, and saving millions of dollars of our staggering war costs. Miracles have been accomplished, but as a military commander I must say frankly that we must have more, and soon. We have not been getting enough to really turn the tide in any battle area. I am not interested in schedules as such. What we need is an increasing stream of bombers and fighters, by the thousands, complete for air combat, ready for our Air Transport Command to deliver them to the various fronts. The next few weeks are highly critical, and even if we should reach a turning point in the war as a whole, there is a long hard fight ahead of us all. Tens of thousands of airplanes will be needed before victory is in sight. If it is a matter of critical materials, we must find ways and means to substitute others and yet maintain the quality of the airplanes in which our courageous young men must fight. American ingenuity and engineering skill is equal to the task.

Again, as a military commander, my chief concern is winning the war. We all know now that gaining air supremacy will play a large part in the final victory. We know that air transport will increasingly aid not only our air operations but the conduct of our entire offensive effort. I am also concerned, however, with a danger that we may find ourselves as little prepared for the vast changes we shall find in the post-war world as we were for the war itself. The loss of our hard-won military supremacy in the air would be a crime, and the failure of this great nation to take a front rank position in the air commerce of the world would be a calamity indeed. Wings of war must be transformed into wings of worldwide understanding and goodwill.

Naval Aviation at War

(*Concluded from page 28*)

shops in every corner of the land, great and small, new and old, and it has caused thousands of shops to leave their peacetime work and devote all their skills and manpower, machines and materials, to the paramount needs of the nation at war.

Naturally, the expansion has not been accomplished smoothly. There are too much of some things and too little of others. Allocation of men, machines, and materials has not been so perfect as to provide adequate quantities whenever and wherever necessary. Engineering difficulties have been and are serious, costly and time-devouring. Labor difficulties have been most serious, largely because skilled artisans and experienced supervisors are so pitifully few. Transportation difficulties have been complex and troublesome. Organization problems are severe obstacles to production.

And finally, the ever-shifting needs of naval air combat, patrol, reconnaissance and transport have complicated all the other problems almost to the point of chaotic confusion. But, the work goes forward! Order is coming into being; mistakes are being corrected; painfully learned lessons are being turned to assets. American airplane industry is definitely on the march, which means that naval air power is definitely on the wing. This time next year will show us the fruits of the titanic task which is even now being accomplished.

There will be many more United States aircraft carrier task forces, as carriers now being built are completed. Those task forces which have preceded them have set a standard for courage and technical skill that will be met as offensive operations drive the enemy back toward his final stand in the islands of Japan.

War Production Effort in Aircraft

(*Continued from page 31*)

balance has been to work from approximations in getting expansions under way, coupled with application of pressure for greater speed and effort selectively on particular companies so as to overcome the time differential and bring the whole program into balance. Occasional instances of airframe plants working at reduced speed in the midst of a production drive effort reflect this determination to acquire balance. On the whole, results have been good and, after a little longer time, this problem will be negligible.

Servicing and Spare Parts – Problems of servicing and maintenance involving spare parts are very real. It is difficult until after some war experience is acquired to determine just what spares are most needed. But having found out, it then takes time to list, order, produce, and then ship such items so urgently needed at the front to "keep them flying." Remember, a reconditioned airplane at the scene of action is more valuable than a new airplane 8000 miles from the front. The pressure for numbers of completed aircraft each month in our production drive makes it difficult to produce and deliver spare parts which use productive capacity but do not get counted in published results. A far better measure than numbers is pounds of product delivered. Present service estimates show the need of greatly increasing the percentage of spare parts in the future and the need of these as our forces see more and more action, will compel their delivery even at the expense of completed aircraft.

Priorities and Allocations – The original system of priorities has yielded gradually to allocations, the freezing of schedules for equipment on approved programs. The problems are still many and serious, with many expedients constantly being introduced for tryout. The latest of these is the Production Requirements Plan which undertakes

to collect the requirements for materials of all U. S. industry and then to allocate available supply, first in broad terms between minimum civilian needs and munitions requirements, and then within the munitions field, between the several branches such as ordnance, aircraft, ships, ammunition, and so on. The reports from industry giving material needs are based on approved schedules. The plan is sound, but tremendous in scope. For aircraft, it is planned that having received *wholesale* allotments from the Production Requirements Plan, after analysis and approval in Washington, these materials can then be scheduled *retail* to companies from the Scheduling Unit in Dayton.

The success of this or any plan of material distribution based on a supply inadequate in many critical items to meet all needs, is measured by the accuracy of making and then meeting schedules. Acceleration above schedules will rob someone else of his requirements, so that we have the anomalous condition of holding down deliveries to schedules (with a small tolerance) in order that the whole program as planned may proceed smoothly and in balance. It is vital that this situation be generally understood by industry and the public at large.

Conversion – This subject, of particular interest in Detroit, has been very inadequately understood. The public was led to believe by those who were uninformed or who had some ulterior motive in so stating, that only a short time would be needed to convert a plant producing automobiles to the production of airplanes. To understand the specific problem properly, it is necessary to grasp first the fundamentals of all modern production which hark back to machine tools, and in mass production to highly specialized tools. These tools are so special that, in the majority of cases, they can be used only for one particular job. A $250,000 multihead machine for performing all operations in fabricating a cylinder head or crankcase section simply cannot be converted to any other use.

Actual experience shows that the tools in an automobile factory usable in producing aircraft or aircraft engines total not over 35% in any case and average about 20%. In many cases the maximum usable are but 15%. Even buildings are frequently unsuited so that new plants have had to be built. In general, conversion has resulted chiefly in the acquisition of management and labor. Conversion is now so far advanced, however, that today the larger automobile companies have labor forces (80% engaged in producing munitions) that are substantially equal to those employed at their previous peak. At the peak of their munitions output, the force will be from 50% to 100% greater than ever before.

It is well also to consider the difference in degree which production connotes when reference is made to automobiles or to aircraft. It was only two or three years ago that orders of but 25 to 50 planes for a given model were welcomed and an order of 100 or 200 was an event worthy of a celebration. A great many automobile assembly lines could turn out 1500 cars per day. Only a few airplane plants at their contemplated peaks will turn out 15 planes per day! Hardly mass production! So methods and techniques in two factories where the output of one is but 1% of the other must differ markedly. The moving production line for aircraft, although probably desirable as an indication of progressiveness and of a method conducive to good planning and orderliness, is relatively unimportant from the standpoint of efficiency in most airplane factories at present.

The plan we followed in getting out aircraft programs under way was first to fill the existing aircraft industry with orders, as by that method quickest results could be obtained. Next, we expanded the aircraft manufacturers to the maximum extent practicable from the standpoint of thinning out management, urging that subcontracting be placed in other industries. Then we started conversion of other industries as prime contractors themselves. That the output has so well met the high schedules set is proof of the soundness of the policy. I do not believe much, if any, greater deliveries could have been made, and the output of the converted companies is only now being felt.

One final word on conversion. The cooperation between the aircraft engine parent companies and the automobile licensees has been excellent. Parts from engines produced by Buick and Pratt & Whitney, and produced by Studebaker and Wright have been interchanged, at random, resulting in "composite" engines that have performed perfectly, demonstrating the fine quality of the products of all. Aircraft engines or propellers are now being turned out in quantity also by Ford, Nash, Chevrolet, and Packard. Airplane deliveries from the automobile industry (except for some subcontracted assemblies) will not be coming out in impressive quantities until late this year, after which rates will mount rapidly, as tooling is excellent.

Subcontracting – Another special problem that has caused concern is the matter of subcontracting. More subcontracting has been called for, and yet we must appreciate the conflicting elements of the two factors involved. First, there is the increase in production output that subcontracting will presumably give us. Yet, strange as it may seem, in most cases, subcontracting at first actually reduces production because of the acceptance of work by firms less experienced than the prime contractor who designed and is building it. This causes a thinning out of the management of the prime contractor's organization in educating the subcontractor. This condition coupled with the other subcontracting difficulties involving more paper work and time in delivering parts, for a considerable length of time actually reduces output rather than increases it. But, of course, the second and real reason for the subcontracting effort has been an attempt to alleviate the distress of those small industries that are suffering because they are practically out of business due to having materials withheld from them by priorities. So, it has been a very difficult thing to balance properly this desire for immediate increase in production, usually obtained by expanding prime contractors facilities, against the socially meritorious desire of relieving distress of those people thrown out of business by priorities. However, if they possess suitable tools to do the defense job, they will continue to get subcontracting business.

The extent and increase of subcontracting is shown by the fact that in March 1941 the average for airplane companies was 13%, which increased to 24% by October 1941, and to 36% in March 1942. This large figure reflects the effect of the government assembly plants just now getting into production, and which resort to subcontracting to the extent of 60% to 80%. Thirty per cent is a fair average of the industry not counting them. In general, it is un-

desirable to subcontract the fuselage and center-section panel away from the assembly plant.

■ Progress

Requirements of secrecy make it difficult to portray our tremendous strides in production output of aircraft as impressively as it warrants. Yet some things can be told to show the trend. First, in dollars of total munitions deliveries the monthly values have increased five-fold from July 1940 to July 1941, and to another four-fold from the latter date. Aircraft has maintained its predominant position in this general increase. The graph of aircraft production deliveries plotted against time has been represented by a curve that has been consistently concave upward showing an ever increasing gain over a straight-line variation. No flattening out will occur for many months to come. As the average weight of our planes will double by the time our number peak is reached because of the preponderance of large bombers and transports, the actual achievement in maintaining this increased output is the more remarkable.

The rate of increase of our aircraft deliveries from month to month is now far greater than it has been at any time in any other country of the world. We give great credit to our aircraft industry for this achievement. The success with which we have met each succeeding program schedule has made it possible to raise our sights from programs laid down early in 1941 that contemplated deliveries in 1942 of 40,000 planes and in 1943 of 60,000, to those set by the President early this year that call for 60,000 this year and 125,000 next. The record justifies our sights at this level and assures close approximation to attainment of this goal.

Following the appeasement period that culminated at Munich in 1938 and then the start of the war in Europe in 1939, we saw our previous minute production of not much over 1000 planes a year accelerate by orders from France and England to bring us to a rate of 500 planes per month in the middle of 1940. At that time Germany was producing 2000 planes per month, half again as many as the Allies when including those received from America. Germany's *Luftwaffe* was then over twice as large as that controlled by the Allies. Our National Defense Advisory Commission got under way in a spirit of "business as usual" with the country engulfed in a feeling of intense isolationism. By November, 1941, just before Pearl Harbor, we had passed through a period of benevolent neutrality to a period of realization by most Americans that life would be intolerable with Germany victorious. The magnificent resistance of the English to the Nazi barbarian had placed us and the whole civilized world eternally in her debt. Likewise, our respect and admiration for Russia in withstanding the German onslaught had become great and sincere. A program for aircraft production in the United States was well along and its future progress assured under the fine leadership of W. S. Knudsen in the OPM. At that time the production rate of the Axis powers was about the same as their adversaries although Axis air forces were still substantially greater. Our own production last fall was approximately 2000 planes per month, with Germany at about 2500.

Then with Pearl Harbor our production increased by leaps and bounds; so much that I now estimate the total United Nations' production is 27% greater in monthly output than that of the Axis powers. Air forces of the two groups are approximately equal. *A year from now both in rate of production and air force total strength we will predominate by 2 to 1.* That will assure victory. But it will only come with increased determination, no relaxation of effort. Yet, knowing what has been accomplished in the past, we can better tackle future "impossibilities" with confidence.

ARMY-NAVY Aeronautical Standardization

(*Continued from page* 33)

of aeronautical matters – shall hereafter exercise its function for the purpose aforesaid under the direction and supervision of the President as Commander-in-Chief of the Army and Navy of the United States.

The membership of the Board is as follows:

Army:

Commanding General, Army Air Forces (Lt.-Gen. H. H. Arnold)

Commanding General, Materiel Command (Major-Gen. O. P. Echols)

Member, Operations Division General Staff (Col. Ford L. Fair)

Secretary: Lt.-Col. Jarvis Butler

Navy:

Chief of the Bureau of Aeronautics (Rear-Admiral John S. McCain)

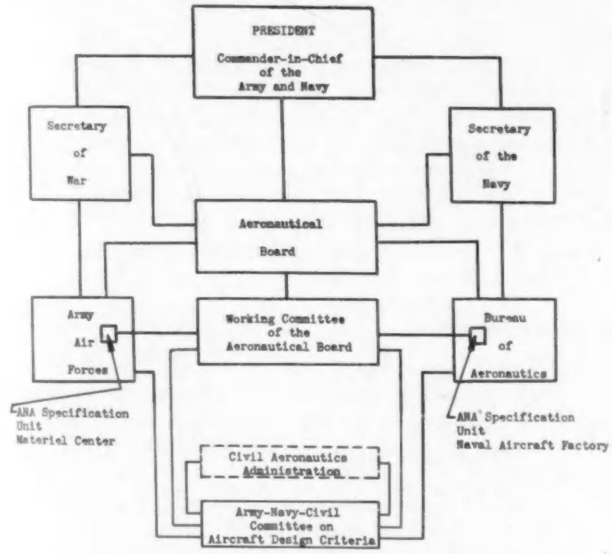
Director of Planning, Bureau of Aeronautics (Capt. H. B. Sallada)

Member Plans Division, Naval Operations (Capt. R. W. Morse)

■ Working Committee of the Board

Since the time the Aeronautical Board was organized, the detail work involved in the various investigations and studies undertaken had been performed by committees appointed by the Board. When the Board took over supervision of Army-Navy aeronautical standardization, it appointed a full-time Working Committee with permanent office facilities and charged the Committee with the responsibility for all matters pertaining to standardization of Army and Navy requirements for aeronautical materiel. One officer, one aeronautical engineer, and one stenographer were detailed from each service to form the original staff. This action was approved by the Secretaries of the War and Navy Departments in February, 1937. Col. D. G. Lingle, A.C., and Captain G. A. Seitz, U.S.N., are now the respective Army and Navy Members of the Working Committee. The two Army and Navy Members of the Committee are not members of the Aeronautical Board but attend all meetings of the Board and report on the progress of AN standardization and other assignments. The Working Committee has been expanded gradually to keep pace with the expanding work load until now the organization comprises about 40 people. This number includes personnel assigned to duties concerned with Army-Navy-British standardization. The personnel of the Committee, including officers, engineers, and clerical staff, is about half and half, Army and Navy, for payroll and administrative

purposes. In spite of this division, the attitude toward AN standardization questions is strictly non-partisan and the interest of AN agreement is uppermost. Many an argument for the Army is won through the persuasive efforts of one of the Naval officers of the Committee, and vice-versa. Likewise, many a clash of conflicting viewpoints is avoided by the introduction of acceptable compromises developed by Committee personnel. The work performed by people in the Committee is closely akin to that of our skilled diplomats and sometimes demands the combined talents of a lawyer and inventor to put it across. The Army and Navy Members of the Committee are also active in other organizations devoted to coordination of Army and Navy aeronautical requirements. Both are members of the Subcommittee on Standardization of the Joint Aircraft Committee. Col. Lingle, as the Recorder of this Subcommittee, maintains a staff of assistants in the office of the Aeronautical Board Working Committee and thus furnishes direct liaison between the two programs. The chairmanship of the Army-Navy-Civil Committee on Aircraft Design Criteria alternates between the Army and Navy Members of the Working Committee each year. Capt. Seitz, as the present chairman, effects the necessary liaison between work of the ANC Committee and the AN standards program. Thus, it may be seen readily that the Army and Navy Members are in an advantageous position to coordinate all activities concerned with the standardization of the services' materiel requirements and are in fact



Army-Navy organization for AN standardization of aeronautical materiel

fully occupied with this task. As a result of the Working Committee's constant contacts with the Army and Navy materiel organizations on specification problems, it has acquired a fund of experience and information which enables it to serve as a liaison office between the Services on many other subjects not directly concerned with AN standardization.

Within the government, the Working Committee maintains close relationships with other agencies and offices concerned with standardization, research, and the development of technical requirements. Among these are: the National Bureau of Standards, the Interdepartmental Screw Thread Committee, the Federal Specifications Board, the National Advisory Committee for Aeronautics, the Forest Products Laboratory, and others.

■ The ANA Specification Units

Practically all of the actual preparation of the ANA specifications and drawings is performed by the ANA Specification Units located at the Materiel Center in Dayton, O., and at the Naval Aircraft Factory in Philadelphia. The exceptions consist of a relatively small number of specifications and drawings prepared by the Committee in unusual emergencies. The purpose of separating this work from the coordination work of the Committee is to permit the actual preparation of standards to be performed in close cooperation with the technical specialists concerned. The Units are staffed with engineers whose sole duty is work on AN standards. Whereas the Units were established in 1938 with working forces of about two engineers and one stenographer, each Unit now comprises approximately ten engineers plus clerical staff. The Unit at the Materiel Center is headed by Major H. M. Cronk, A.C., with C. J. Rowe as senior engineer. W. J. Petransky is senior engineer of the Unit at the Naval Aircraft Factory. The function of the ANA Specification Units is twofold, namely: (1) the preparation of specifications and drawings; and (2) the presentation of their respective service's comment on proposed standards prepared by the other Unit. In both of these functions the engineers of the Units, in their contacts with technical personnel, constantly stress the objective of Army and Navy agreement. When disagreement occurs, the Unit engineers study the reasons underlying the differences of opinion and are frequently able to overcome objections by devising compromise requirements satisfying the needs of both services. The engineers of the Specification Units, as in the Working Committee, far from being only specification writers, are actually full-time specialists in the coordination of Army and Navy requirements. The success of Army-Navy standardization largely depends on the efforts and skill of the personnel in the Units.

■ The Working Procedure

When the Army and Navy Members of the Working Committee first assumed their duties, there was plenty of work to do but no working procedure and no organization to prepare the new standards. Starting with an exhaustive study of the past record of AN standardization, they established two basic working principles. The first was that the ANA specifications and drawings would contain no differences between Army and Navy requirements and would be published as identical joint documents for both services. This was both a working principle and an objective. It effectively ruled out agreements to disagree and established the "hard way" as the only way to AN standardization. This principle has been adhered to in all ANA standards without exception, in spite of the many cases in which it would have been expedient to permit statement of non-common requirements. The second principle was that the responsibility for preparation and coordination of ANA standards between the services should be assigned to personnel designated as full-time ANA standard personnel with no other duties. This is the principle that

took Army-Navy coordination out of the class of experiment and established it on a basis of official policy. The ANA Specification Units are founded on this principle. Back in the year 1938, money was scarce and the services had to stretch their appropriations. When they set aside a budget to cover a work program, they were quite sure they wanted the work done and wanted results. The record since then has justified the expenditures.

In preparing specifications or drawings, two problems exist. One is determination of what the requirements shall be and the other is how they shall be expressed in the specification, or briefly, specification form. The first problem, determination of requirements, is left entirely to the services, whereas the Working Committee assumes responsibility for "form and substance." By "substance" is meant the subject matter of the standard, including such questions as whether to include two or more particular items in the same specification or to use different specifications, whether to include a drawing of the item in the specification or to show it on a separate AN drawing, and so on. Form is a problem that is never completely settled. It is established to fit the average case but is constantly subject to alteration to suit the needs of particular items. Nevertheless, it is an important consideration with government specifications, due to the great number of such specifications currently in use and their continuing status in repeated purchases. The form of ANA specifications (and drawings) is governed by the "Aeronautical Board Outline of Procedure for Preparation and Issue of ANA Specifications (and Drawings)" which covers such details as numbering, titling, referencing, arrangement of text, tabulation, and so on. This publication, prepared by the Working Committee, is the ANA specification writer's bible. When a controversial question of form has been decided and made a part of the Outline of Procedure, all future specifications are written accordingly and the question is no longer a point of argument. This practice saves much time and effort in coordination.

The routine procedure for coordinating and issuing ANA standards may appear somewhat complicated to people outside of the government, but is actually quite direct considering the action accomplished. Recommendation for issuance of an ANA standard may originate from any source and is referred to the Working Committee. The Committee determines whether the matter is a suitable subject for an ANA standard and, if so, assigns the work of preparation to one of the ANA Specification Units. The standard is then prepared on consideration of all information available, such as existing Navy and/or Army specifications, test reports, conference agreements, industry's suggestions or specifications, and so on, and is forwarded to the Committee. It is then reviewed for "form and substance" and forwarded to the other ANA Specification Unit to obtain the comment or approval of that service. If the proposed standard is not acceptable as first submitted, the ANA Specification Unit prepares a set of detailed comments setting forth each objection together with specific reasons to support the objection, and proposes alternate requirements for consideration. All papers are then returned to the Committee. The Committee reviews the comments and, when it appears that agreement can be obtained through the normal course of coordination, the specification is returned to the originating service for revision and resubmission. Industry comment and recommendation may also be invited at this stage. If the points of disagreement are particularly controversial, the Committee may elect to obtain final agreement by means of an AN conference rather than by extended correspondence. Approximately 70 such conferences have been held so far this calendar year. Immediately following final settlement of the issues involved, the specification is revised and services final approval for technical requirements is indicated by signatures of personnel of the Materiel Center and the Bureau of Aeronautics authorized to bind their respective services to the requirements of the standard. Although ANA standards work assigned to the Navy is performed by the ANA Specification Unit at the Naval Aircraft Factory, all such work is subject to the approval of the Bureau of Aeronautics. Likewise, final approval for the Navy of all proposed standards originating with the Army is the prerogative of the Bureau. The specification is signed by the Army and Navy Members of the Working Committee to indicate approval of form and substance and the Committee then takes charge of printing and distribution, which is accomplished in Washington. The outstanding feature of this procedure is that no specification is released until it is finally approved in all details, however slight, by both services, and that standards are printed exactly as approved without further change.

As stated in the preamble of ANA specifications and in the note along the left border of ANA drawings, the ANA standard thus issued is approved by joint action of the War and Navy Departments as the Army-Navy standard for that product and supersedes all antecedent specifications or drawings of the services for the same product. Normally, the use of the new ANA standard by the services for procurement of aeronautical materiel becomes mandatory six months after date of issue, although it may be used at any earlier date. In many cases the ANA standard is used for procurement as soon as it is off the press while, in other cases, due to existing production circumstances, its actual use in aircraft production may be delayed considerably beyond the six months' period. Consideration is now being given to establishing a procedure whereby a definite schedule for putting each ANA standard into effect for both services will be determined while the specification is being coordinated, or as soon after issue as possible.

■ Specifications

ANA specifications and drawings are divided into various types or classes according to the subject matter. There are three main classes of specifications: material or procurement specifications, process specifications, and design specifications. The first class, which states the procurement requirements for materials, parts, and items of equipment, is by far the largest. Examples of this class are:

AN-CCC-S-371	Silk; Parachute.
AN-S-9	Steel; Bar-and-Rod, Molybdenum (4037).
AN-GG-A-461	Altimeters; Pressure.
AN-L-11	Lights; Electrically Retractable, Landing

The second class, process specifications, states the requirements controlling critical processes used in aircraft construction. This class also includes certain tests and inspection methods widely applicable and referenced in many material specifications. Examples are:

AN-QQ-H-186	Heat-Treatment-of Aluminum Alloys; Process for.
AN-QQ-S-91	Salt-Spray-Corrosion Test; Process for.
AN-QQ-M-181	Metals; Magnetic Inspection of (Process and Application).

The third class, design specifications, states the design requirements controlling particular aircraft systems and installations such as:

AN-B-2	Brake Systems; Aircraft (Design of).
AN-I-2	Installation of Instruments and Instrument Boards; General.

The form for each of these classes is considerably different from the others, as might be expected from the subject matter. However, the same form is used for all specifications within each class.

It may be noted from the foregoing examples that the specification numbers follow two different make-up patterns. A word of explanation may be helpful. The type of number consisting of only three parts, "AN" – (a capital letter) – (a number), for example: AN-S-9, follows the new system now employed for all ANA specifications. The "AN-" is obvious; the capital letter is always the first letter of the first word of the title, and the number is merely a serial number assigned consecutively within each letter group. No two ANA specification numbers are the same. The type of number consisting of four parts is simply a Federal Specification type of number prefixed by "AN." Until the three-part system was adopted, all ANA specification numbers were assigned by the Federal Cataloger. The capital letter, double, or triple letter immediately following the "AN" is the Federal symbol indicating the procurement group to which the item belongs. The single capital letter following the group symbol, and the number, have the same significance as those in the new type of ANA specification number. Since so much curiosity has been expressed by people both in and out of the Government as to the meaning of the Federal procurement group symbol, it is considered worth while to include here an explanation of the symbols which have been used as part of the old style of AN specification numbers. The following table identifies each of these symbols with the Federal procurement group to which a product might thus be assigned:

A – Aircraft, boats, and ships.
F – Boilers, engines, and tanks.
J – Cable and wire (insulated).
L – Cellulose and products.
O – Chemicals.
R – Coal tar and products.
W – Electric apparatus.
DD – Glass and glassware.
FF – Hardware.
GG – Instruments.
HH – Insulating materials.
JJ – Knit goods, netting and webbing.
NN – Lumber products.
QQ – Metals.
RR – Metal products.
TT – Paints, pigments, varnishes, and products.
VV – Petroleum and products.
WW – Pipe, pipe fitting, plumbing fixtures, tubes and tubing (metallic).
XX – Pumps.
ZZ – Rubber and rubber goods.
CCC – Textiles (yardage).
DDD – Textile products.
GGG – Tools.
JJJ – Vegetable products.
LLL – Wood products.

ANA specifications, like other government specifications, are intended to serve as the specification to be used for repeated purchase of the same commodity and are revised or amended from time to time as necessary to incorporate improvements. In this respect they differ from the specifications for one particular model of engine or airplane, and from architects' and construction engineers' specifications, which are written to cover one contract only. As a result of this permanent character, they are used extensively by reference in other specifications, thus avoiding the necessity of repeating requirements which are common to many products. For example, Specification AN-TT-P-656 for Primer; Zinc Chromate is referenced and made a part of many specifications for items of equipment requiring the use of this primer in its protective finish. The specification for Screw Threads; Standard, Aircraft, AN-GGG-S-126 is referenced in specifications and drawings for all parts involving screw threads. In some specifications for complex items of equipment, there may be as many as 20 or more applicable specifications and drawings listed as forming a part of the product specification. The specification for engines lists 27 specifications and 45 drawings. Contractors are required to assure themselves that they are in possession of the latest issues or amendments to these applicable specifications for bidding purposes. Although this procedure of referencing one specification within another as practiced in all ANA, Army, Navy, and Federal specifications is well known to experienced contractors to the government, few people understand the far-reaching effect it has on standardization of government equipment and the resulting benefits to industrial production. In the case of such a highly complicated machine as the airplane, this practice provides a degree of homogeneity of materials and uniformity of design elements which is of immense assistance to the general production effort. This feature of overall standardization would be impossible of attainment if each designer and specification writer were free to choose any material or design practice which struck his fancy in lieu of established standards covered by existing specifications.

The "AN9500 series" specifications are now coordinated and issued by the Working Committee in the same manner as ANA specifications and are listed in the ANA index. They may be referred to and used the same as ANA specifications for all purposes. At the time of their original issue by the services they contained a few non-common requirements which excluded them from classification as ANA specifications, but since 1940 these differences have been eliminated. The "AN9500 series" has been closed, and no new specifications will be added with this style of number. The existing AN9500 specifications cover the general AN requirements for engines, carburetors, magnetos, and ignition shielding and, as a group, constitute the most important set of related specifications issued so far. The general engine specification defines the basic requirements governing the design of all production engines for Army and Navy aircraft. It is complemented by the specifications for type test and acceptance test and by the outline requirements for the engine manufacturers' model specifications. The general engine specification and its complementary specifications thus form a part of the engine manufacturers detail specification and assure that the basic engine design is acceptable to both the Army and the Navy. As a result of this specification and the coordinating influence of the effort put forth in its development, there now exists standardized production of aircraft

engines. Until a couple of years ago some engine manufacturers were running four production lines simultaneously on the same model engine; one for Army engines, one for Navy, one for foreign orders, and one for commercial customers. Furthermore, they had to provide for dual inspection; one for Army and an entirely separate one for Navy, both in the same plant. Now there is one production line for one model and the Army and Navy have established a system of joint inspection. Under this joint system one service assumes complete responsibility for inspection in the plants of one manufacturer and the other service performs the same function with another manufacturer. Each accepts the decisions of the other's inspectors. This division of the total work load has been a most important factor of assistance in providing government inspection in pace with the greatly expanded engine industry.

ANA Intermediate Specifications represent a relatively new and limited class. They are emergency specifications issued as a stop-gap standard pending issue of a full-fledged ANA specification for the same product. In certain cases the services agree that procurement should and will be made under common requirements, but the need for immediate action is so urgent that it is impracticable to wait for preparation and coordination of a complete new ANA specification, especially when it may be lengthy. If either or both services already have a reasonably satisfactory specification, such a specification is adopted as the basis of an Intermediate Specification. The Intermediate consists of the complete service specification and an ANA yellow cover sheet. The cover sheet carries an ANA number in the regular ANA series and states that the specification consists of the service specification, number so-and-so, attached thereto with changes as listed on the cover sheet. It then states any changes in the basic specification which have been agreed to for the Army-Navy standard.

Since these Intermediate Specifications are short, seldom more than two pages, they require much less time in preparation and printing and are well adapted to serve the needs of immediate purchase following Army-Navy agreement on requirements. Most agreements on such urgent items are established in AN conferences, and it is frequently possible to have the ANA Intermediate printed, assembled, and in the hands of the procurement branches within two or three days following the conference. The ANA Intermediate assumes full status with the regular form of ANA specification and is listed in the ANA index without any distinction as to its form. The Intermediate supersedes the antecedent specifications of the Army and Navy, including the one used as part of the Intermediate. When the regular ANA specification is prepared for the same product it is issued as revision "a" of the same number as that used for the Intermediate, thus avoiding necessity of changing other specifications and drawings which may have referenced this number.

Of the 300 and more odd specifications that have been issued it is difficult to single out any one as being more important than another. All are important in their respective fields of application. However, the circumstances surrounding the need for certain specifications or groups of specifications and the problems encountered in their preparation are worthy of mention. The following examples should be considered only as representative of many other similar subjects.

Electrical Connectors for Aircraft (AN-W-C-591) – This specification covers the plugs and receptacles used for connecting and disconnecting electrical circuits in aircraft. Prior to issuance of the ANA specification both services accepted commercially designed products known to be serviceable. This condition meant that, when a piece of electrical equipment containing a receptacle was furnished for installation in an airplane, it was necessary either to have the plug furnished with the equipment and wire it on installation or to procure in advance the particular manufacturer's plug to fit the receptacle. The complications in procurement, stocking, and maintenance were endless. The AN standard series of connectors, now in wide use and extensively advertised, establishes a fixed range of sizes of plugs and receptacles and so defines the construction that the receptacle of given AN part number and AND contact arrangement number as manufactured by one manufacturer will fit a plug of corresponding AN design as made by another manufacturer. The source of manufacture thus ceases to be a variable in the use of the parts and the plugs and receptacles may be positively identified by use of the AN part numbers alone. Plugs may be purchased and stocked independently from receptacles. The design of these connectors, of course, is correlated to the design of the AN standard electrical cable (AN-J-C-48) and the AN standard series of conduit fittings to assure proper fit and mating of all parts of the installation.

Aluminum and Aluminum Alloy Rivets (AN-FF-R-551) – This is the procurement specification for all such rivets used in the construction of military aircraft. It is complemented by the following AN drawings which provide AN part numbers for each diameter, length, and material in which the rivets are manufactured and used:

AN426	100-deg countersunk head
AN456	Brazier head
AN442	Flat head
AN430	Round head

There are four head forms and five available alloys resulting altogether in 1410 different head-diameter-length-material combinations. This represents a considerable reduction in the number of combinations existing and in use by manufacturers before the ANA standards were issued, but an effort is now being made to reduce this variation still further. The rivet used in the largest quantities is the 100-deg countersunk. This is the rivet employed for flush-riveting of the sheet skin on wings, fuselage, tail surfaces, cowling, and any other parts exposed to air flow. Several years ago there was considerable difference of opinion in the industry as to what the included angle of the head should be to provide the greatest efficiency in production and strength. These angles ranged from 78 deg all the way up to 120 deg and there was much to be said for each. It was obvious however that such variations were entirely incompatible with efficient maintenance by the military services or with subcontracting production. In the latter case, a subcontractor doing work for several prime contractors who would insist on their own particular head angle would be required to maintain several different sets of countersinking and "dimpling" tools. Fortunately, the National Aircraft Standards Committee had already adopted the 100-deg head as a standard and the two services agreed to accept this rivet as the AN standard for the countersunk type. Present-day production of aircraft rivets as measured in poundage is astounding. Expressed in numbers of rivets, the figures are astronomical.

Instruments – Approximately 20 of the major flight and engine instruments have now been covered by AN standards, and as many more are in course of preparation. The subjects range from tiny jewel bearings to complete automatic pilots. Prior to the advent of AN standardization, both services, working with the same manufacturers, had developed their instruments along parallel lines to perform essentially the same functions but with just enough difference in design to require two separate production lines and to preclude interchangeable installation in Army and Navy aircraft. The AN instruments, which in many cases combine the best features of both antecedent Army and Navy instruments, are now just coming into use on a quantity-production scale. Instruments, being government-furnished equipment, offered no problem to airplane manufacturers in so far as procurement of duplicate stocks was concerned, but they did involve problems in the design of instrument boards. Until recently, a particular primary training airplane being used by both the Army and Navy was being delivered to the Army with Army instruments and to the Navy with Navy instruments. As part of a comprehensive program to make the airplane completely standard, the services have agreed on a common instrument board with common instruments all of which will be AN standard as soon as all the required AN standard instruments are in production.

Perhaps the most difficult of all the specific problems encountered in AN standardization of instruments has been the airspeed indicator. The pitot-static tubes composing the installation are already standard and in use. Use of a completely common indicator however is "stymied" by a fundamental factor. The Navy measures speed in knots whereas the Army uses miles per hour. On single-revolution indicators the same mechanism can be equipped with the appropriate dial, and dials can even be changed by the services but, in the case of multiple-revolution indicators, the mechanism itself must be different to conform to the type of dial used. The instrument as a whole cannot be completely AN standard until both services adopt the same unit measure of speed. The knot is based on the nautical mile which is one minute of arc of a great circle on the earth's surface. Obviously this is a great convenience to navigators and in this global war cannot be sacrificed. The Army's "miles per hour" is based on the statute mile which is somewhat awkward for navigation but ties in with cross-country maps. Standardization on knots, although desirable from many angles, would require a tremendous amount of change and adjustment of existing maps, handbooks, and other paper records. As production increases the effects of this difference in practice becomes more and more troublesome. It is an outstanding example of a problem which should have been undertaken and resolved about five years ago.

Steel – There are now approximately 35 ANA specifications in active use covering aeronautical steels in the form of bar, rod, wire, sheet, and tubing. The number of steel compositions represented is of course much smaller than the number of specifications. These are the specifications which establish the standard of quality and the uniform compositions for the bulk of the steel used in airframes construction. Since Army-Navy standard steels have been used in aircraft for many years, it might be wondered that they should be an active subject of ANA standardization at this time. The fact is that the current situation with regard to use of critical materials has placed added responsibility on the Army and Navy to establish the most efficient balance between quality required and quality which can be produced most efficiently. Although the tonnage consumption of steel by the aircraft industry is small as compared to shipbuilding, the quality requirements run extremely high for all types used. Moreover, the compositions now widely employed in airframe construction were adopted for the purpose after years of testing and service experience. The industry and the services alike have confidence in these steels, based on familiarity with their behavior in production and use. Aircraft now in production were designed on allowable stresses known to be obtainable from the standard aeronautical steels. The introduction of new steels, particularly with aircraft production on such a large scale, requires exhaustive laboratory tests and shop fabrication trials. So far, the number of compositions added to the list of AN standards has been limited. However, the maintenance of the entire group of steel specifications in up-to-date status, to provide new specifications as needed and to revise or amend existing specifications, has required constant attention and prompt action on the part of the Working Committee and the materials personnel in the two services.

Oxygen Equipment – This program, which is not yet finally completed, includes the complete oxygen system, from the oxygen in the cylinder, through the mask, to the user. Under the separate Navy and Army specifications, the system and all its parts, including the oxygen, were different. Navy personnel operating Army-designed aircraft were required to be alert to the differences in operation of the Army type of oxygen system as compared to Navy systems with which they were familiar. Army personnel in Navy aircraft had the same problem. Upon first consideration the apparent solution would be to simply adopt one or the other system. However, circumstances of oxygen equipment production and field maintenance rendered this action inadvisable. The alternate approach was to create an AN standard for component parts, with the parts so designed that an installation composed of these AN standard parts would function under either system of operation. This has been done, and the effect is the elimination of the system design as a factor governing its operation by air personnel. Starting with the oxygen itself, the lines, fittings, regulator, valves, and the mask, have all been covered by AN standards. This method of dealing with the problem has avoided undesirable production readjustments and has facilitated the work of installation and maintenance

Oil Coolers (AN-C-75) – This equipment is used on aircraft to cool the engine lubricating oil. Up to the time AN standardization was undertaken, both services had followed the practice of accepting oil coolers of commercial design conforming to general specifications provided the coolers were known to be serviceable. Neither service had standardized on a fixed series of sizes and capacities. Consequently, there was no assurance that a cooler of a given cooling capacity as made by one manufacturer would fit an installation originally designed around a cooler of another manufacturer although the capacity required was the same. Interchangeability of coolers between Navy and Army airplanes was entirely out of the question due to fundamental differences in the oil circulatory systems. This

difference was reflected in the design of the oil temperature regulator valves which, in turn, determined the design of the valve mounting flange on the cooler. Through the combined efforts of the Army and Navy, the oil-cooler manufacturers, and representatives of the aircraft industry, an AN standard series of oil coolers has been established which provides for complete interchangeability of oil-cooler units of a given capacity, up to the valve, and including the valve mounting flange. At this time, further investigation is under way on the problems involved in standardizing the valves themselves. The AN standardization of oil coolers provides positive identification of each size with respect to dimensions, weight, cooling capacity, and so on, and, within any given capacity, assures interchangeability between installations on Army and Navy aircraft.

The Army Air Forces and the Bureau of Aeronautics, in establishing joint specifications for procurement of aeronautical materiel, endeavor to coordinate their requirements with other branches of the Government wherever a common interest exists. The Civil Aeronautics Administration, not being a major customer for aircraft, has only a minor interest in the determination of procurement requirements for aircraft parts and materials. In the field of airport equipment, however, the CAA, as a large-scale purchaser, has a direct responsibility and plays a leading part in the development of satisfactory procurement specifications. The Materiel Center, Bureau of Aeronautics, and Civil Aeronautics Authority, working under the cognizance of the Working Committee of the Aeronautical Board, recently have completed and issued a series of ANA specifications and drawings covering all classes of airways, airport, and seadrome lighting equipment and aids. Equipment conforming to these AN standards is now in use by the military services and the CAA in new air base and airport installations.

Drawings

The ANA drawings, either singly, or collectively in the form of a "Standards Book," perform an extremely important function in the development and the dissemination of ANA standard requirements. The drawings are divided into two classes – "AN" standard "part" drawings and "AND" standard "design" drawings; the first class greatly outnumbering the second. All are printed in black and white on the standard government 8 x 10½ size sheet. The Army-Navy Aeronautical Standard illustrated as part of this article is typical of hundreds of other "part" drawings.

The purpose served by an AN part drawing is multifold. In cases where there is no specification it serves as the complete procurement document. When a specification also applies, the specification and drawing complement one another and, together, completely define the product, all dimensional requirements being contained on the drawing. All the AN part drawings together, when bound as a book, constitute a catalog of the aeronautical materials, parts, and equipment items which are standard for use on both Army and Navy aircraft. Practically all aircraft engineers and draftsmen are familiar with the existing Army Air Forces and Naval Aircraft Factory standards books. An ANA project is now under way to supersede all drawings in these books with ANA drawings and thus substitute an ANA standards book in place of the separate Army and Navy books in so far as airplane contractors' use is concerned. Another important purpose of the ANA part drawings is to provide an AN part number for every part or piece of equipment which is standard. The AN part number is composed of the drawing number, such as AN210, followed by a dash number, -1, -2, -3, etc. to designate the particular size part concerned, for example, AN210-3. An AN part number, when assigned to a part, is applicable to that one part only, and all parts which bear the same AN number are therefore interchangeable. Hence the AN part number alone completely defines the article and is extremely useful in stocking, ordering, or as a part designation on other drawings. In the design and manufacture of Army and Navy aircraft it is a basic requirement that AN parts and part numbers therefore shall be used wherever they are suitable for the purpose. The standards book containing the AN standard drawings thus becomes the designer's source book. When he needs a bolt, he selects the proper size from the AN standard series and identifies it on his drawing by the AN part number. The same procedure is followed for scores of other items such as cable terminals, clamps, pulleys, rivets, tube fittings, electrical connectors, lamps, valves, bearings, switches, and so on. These AN parts are carried as regular stock in American repair bases and on aircraft carriers all over the world. When such a part is damaged, it can be identified instantly and replaced from stock with complete confidence as to the interchangeability and serviceability of the replacement part. People outside of the Army and Navy generally, do not appreciate the vitally important aid to materiel maintenance which is provided by this policy of parts standardization. The fact that AN standardization had been in effect for years preceding our sudden entrance into this war is now a factor of definite assistance which we could ill afford to do without. The establishment of such a standardization policy, the development of the standard parts themselves, their production, their use in airplane manufacture, and their distribution to repair bases, is a task which cannot be accomplished in a matter of months. Had this basic policy and its implementing procedures not been already functioning it would be almost too late to begin. Or, stated in other terms, if the nonstandard parts practices of our domestic hardware or appliance industries, and others, prevailed in aircraft manufacture, it is likely that a sizable percentage of our planes now flying would be on the ground for want of some small part with an odd-size thread.

The other class of drawings, Army-Navy Aeronautical Design Standards, serves a different though equally important function. These drawings define certain design elements which do not fall in the category of parts but which must be held to standard dimensions in order to assure proper mating with AN standard parts. Examples are: threaded bosses, conduit connection hubs, mounting flanges, accessory drives, rim contours, plug and receptacle contact arrangements, and so on. It is obvious that none of these items is purchased separately but their design must be uniform and the dimensions precisely controlled. Another field of use for the design drawings is in standardization of sizes of tubing, metal sheet and bar stock, installation arrangements, identification colors for fluid lines, minimum tube bending radii, and so on. The numbers of the design standard drawings are composed of the term "AND" followed by a serial number. The "D," indicating "design," is added to the "AN" to distinguish

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July 9, 1942

ARMY-NAVY AERONAUTICAL SPECIFICATION
PUMPS; HYDRAULIC HAND

This specification was approved on the above date by joint action of the War and Navy Departments, for use in the procurement of aeronautical supplies and shall become effective not later than January 9, 1943. It may be put into effect, however, at any earlier date after promulgation.

A. APPLICABLE SPECIFICATIONS.

A-1. The following specifications and drawings of the issue in effect on date of invitation for bids shall form a part of this specification:

A-1a. AN Aeronautical Specifications.-

AN-QQ-A-696	Anodic-Films; Corrosion-Protective (for) Aluminum Alloy
AN-H-2	Hydraulic Systems; Design, Installation, and Tests of Aircraft (General Specification for)
AN-VV-O-366	Oil; Hydraulic Aircraft
AN-QQ-P-421	Plating; Cadmium

A-1b. AN Aeronautical Standard Drawings.-

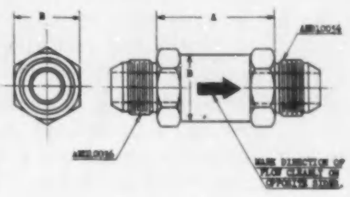
AN6201	Pump - Hydraulic Hand
AN6225	Packing - "V" Ring Hydraulic
AN6226	Packing - "U" Cup Hydraulic
AN6227	Packing - "O" Ring Hydraulic
AN6228	Adapter - "V" Ring Female Hydraulic Packing
AN6229	Adapter - "V" Ring Male Hydraulic Packing
AN6230	Gasket - "O" Ring Hydraulic

B. TYPES.

B-1. This specification covers one type of hydraulic hand pump.

C. MATERIAL AND WORKMANSHIP.

C-1. Material.- Materials used in the manufacture of hydraulic hand pumps shall be of high quality, suitable for the purpose and shall conform to applicable Government specifications. Material conforming



AN PART NO.	TUBE O. D.	RATED FLOW CAPACITY G.P.M.	A ±1/32	B
AN6207-4	1/4	1.2	1-17/32	.688 +.0025 −.004
AN6207-5	5/16	2.3	1-3/4	.750 +.0025 −.004
AN6207-6	3/8	3.5	1-3/4	.813 +.0025 −.004
AN6207-8	1/2	6.0	2-7/32	1.000 +.0025 −.004
AN6207-12	3/4	16.0	2-3/4	1.375 +.003 −.005
AN6207-16	1	29.0	3-5/16	1.625 ±.005

DIMENSIONS IN INCHES.
THIS DRAWING AND THE SPECIFICATION COMPLEMENT ONE ANOTHER, AND TOGETHER COMPLETELY DEFINE THIS PRODUCT.

APPROVED 7-11-42 REVISED

PROCUREMENT SPECIFICATION	ARMY-NAVY AERONAUTICAL STANDARD	AN 6207
AN-V-5	VALVE-HYDRAULIC CHECK	

ANA BULLETIN NO. 114
September 3, 1942

ARMY-NAVY AERONAUTICAL BULLETIN
PACKING; HYDRAULIC, SYNTHETIC

Specification AN-HH-P-114
Drawings AN902
AN6225
AN6226
AN6227
AN6230

1. This bulletin contains the list of hydraulic synthetic packing products considered acceptable under the specification and drawings indicated. Each product is identified by its compound number and/or shape number and the name of the manufacturer.

"V" Ring Hydraulic Packing:
AN Aeronautical Specification: AN-HH-P-114, Class "A"
AN Aeronautical Drawing: AN6225

MANUFACTURER'S COMPOUND NO.	MANUFACTURER'S SHAPE NO.	MANUFACTURER'S NAME
XXXX	XXXXX	John Doe Company
XXXXXXX	XXXX	XXXXX XXXXXXX X XXXXXX XXX
XXXXX	XXXXXXX	XXXXXXXX XXXXX X XXXXXX XXX
XXXXXX	XXXXXXXXXXX	XXXXXXXXXX XXXX XX
XXXXX	XXXXXX	XXXXXXX XXXX X XXXXXX XXX

AERONAUTICAL BOARD
INDEX
OF
ARMY-NAVY AERONAUTICAL STANDARDS

Including
ARMY-NAVY AERONAUTICAL SPECIFICATIONS
and
ARMY-NAVY AERONAUTICAL STANDARD DRAWINGS

Issued by
THE WORKING COMMITTEE OF THE AERONAUTICAL BOARD

4844 Navy Building, Washington, D. C.

July 1, 1942

NOTICE: Copies of the specifications and drawings contained in this index are now available to contractors and prospective contractors to the Government upon application to either the Bureau of Aeronautics, Navy Department, Washington, D. C., or to the Materiel Center, Army Air Forces, Wright Field, Dayton, Ohio. Naval activities should make application to the Manager, Naval Aircraft Factory, U.S. Navy Yard, Philadelphia, Pennsylvania.

** Items marked ** are new standards issued since date of last index.

Typical Army-Navy Aeronautical Standard specification drawing, index, and bulletin

the design standards from the AN part numbers. Although dash numbers are sometimes used with "AND" numbers these numbers are never used as part numbers.

One of the most important items of standardization accomplished under the cognizance of the Working Committee and issued in the form of "AND" drawings, is the standardization of aluminum tubing sizes, alloys, and tempers. The objective of the coordination effort in this subject was somewhat different than for the usual run of aeronautical standards in that it was motivated primarily by the necessity of increasing the capacity of existing tubing production facilities to furnish tubing in the quantity ordered by the aircraft industry. The tubing industry stated that, if the variation in sizes ordered could be reduced drastically, the total output could be increased materially. The determination of what sizes should be established as AN standard and what sizes might be eliminated as unnecessary was a major undertaking, particularly when it was understood that tubing production would be immediately restricted to AN standard sizes except for a limited and closely controlled number of justifiable deviations which would be granted for a temporary period only. However, through the combined efforts of the two services, the War Production Board, the tubing industry, and the aircraft industry as represented by the National Aircraft Standards Committee and the SAE Aeronautics Division, standards were established which are now in effect. Last reports in August estimated conservatively that the production increase which had occurred as a result of this size standardization was approximately 10%. The value of this action to the industry and to the general war effort is obvious. Similar standards have been published for aluminum-alloy sheet and, at time of writing, others are being undertaken for aluminum-alloy bar and rod, and for steel tubing.

AN drawings of both classes generally receive much wider distribution than do specifications. The services distribute several thousand copies of each issue and about a third of these are printed on thin paper suitable for blueprint reproductions. It is the services' desire that a copy of the applicable AN drawing be readily available to all persons concerned with the part, including the draftsman who originally specifies its use, the purchasing agent, the manufacturer of the part, the stockkeeper in the airplane plant, the airplane production personnel, the stockkeeper in the Army or Navy repair base, and the operating squadrons. Such distribution is already in effect to a considerable degree and is rapidly enlarging.

■ Coordination with Industry

The development of practicable specification requirements is a process of balancing what is wanted against what can be furnished. The services, as the customers and the users, determine what is wanted from their experience in the operation and maintenance of military aircraft. This procedure, of course, is fundamental, since in all fields it is the customer's responsibility to state his requirements. However, ANA specifications for the most part are in the class of production specifications as contrasted to experimental and, in order to enforce their use, it is necessary to know in advance of their issue that the product so specified can be furnished by the industry with a minimum of delay. This result is accomplished by coordinating proposed ANA specifications with representative manufacturers who will supply the product. It is emphasized again that such coordination requires balancing of what is desired against the ability and capacity of the industry to produce it. If the services should insist on specifying the ideal in quality and performance and refuse to make any compromise in the interests of production, actual procurement of the product may be delayed to an impracticable degree. On the other hand, if the manufacturers strive always to restrict the specification requirements to fit the article actually in production, progress in development will be stifled. There is a decided difference between the unavoidable and the unattainable. In some cases, the article of commercial quality which is immediately available from a wide source of supply is entirely adequate and is specified. In many other cases, however, extra quality and improved performance are essential and the specification must be written accordingly. When this quality and performance are not available, they must be attained through a process of development which may include: change of materials, better tooling, redesign, additional test data, and so on. Fortunately there is a practicable middle ground to which the specification requirements can be adjusted to stimulate development and at the same time not sacrifice present production facilities. The personnel of the Bureau of Aeronautics and the Materiel Center who are responsible for the parts and materials composing service aircraft, through long experience in this work, and with service operation background, are well fitted to decide what the compromise requirements shall be.

The administrative machinery for obtaining the comments of the industry on proposed ANA standards is now well developed. In 1940, at the request of the Working Committee, the Aircraft Production Division of the War Production Board (then OPM) sponsored a joint meeting of the standardizing organizations then active in the aeronautical industry, to determine a proper allocation of activities in the interest of avoiding conflict or duplication of effort. The Standards Coordination Unit of the Aircraft Production Division, headed by C. E. Stryker, assumed responsibility for coordinating the activities of these industrial groups. Present allocation of cognizance between industry standardizing groups is as follows:

SAE Aeronautics Division – Composed of engineers in the aircraft engine, accessory, equipment, and materials industries serving voluntarily on technical subcommittees assigned to special subjects. The activities of the SAE Aeronautics Division have been described in detail in previous issues of the SAE Journal.

Cognizance of:

Engines – (Matters pertaining to the technical development of standards)

Accessories and Equipment

Propellers

Materials and Processes

National Aircraft Standards Committee – Composed of standards engineers and specialists from the major aircraft manufacturing companies and directly representing these companies.

Cognizance of:

Airframes – (Including standard parts and systems and installations, such as, hydraulic systems, electrical systems, power plant installation, and so on)

Engine Technical Committee of the Aeronautical Chamber of Commerce of America, Inc. – Composed of adminis-

trative personnel of the engineering departments of all the aircraft-engine manufacturers.

Cognizance of:

Engines and the engine accessories essential to the operation of the engine – (Contractural matters of a non-competitive character related to the requirements of ANA standards and recommendations for changes in AN standards)

Airplane Technical Committee of the Aeronautical Chamber of Commerce of America, Inc. – Composed of administrative personnel of the engineering departments of all the airplane manufacturers.

Cognizance of:

Airplanes – (Matters related to the requirements of general airplane specifications and recommendations for changes in these specifications.)

Society of Aeronautical Weight Engineers, Inc. – Composed of the weight engineers of all the airplane manufacturers.

Cognizance of:

Aircraft Weights – (Note: On standards subjects, the SAWE functions in collaboration with the NASC)

Other Commercial Standardizing Organizations – The following associations and societies represent a partial list

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SAE Coming Events

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Jan. 11-15, 1943 — **War Production-Engineering Meeting (and Engineering Display)**
Book-Cadillac Hotel – Detroit, Mich.

■

Buffalo – Nov. 11

Markeen Hotel; dinner 6:30 p.m. Engine Symposium. Naval Engines – Chauncey J. Hamlin, Jr., Sterling Engine Co. Aircraft Engines – W. Berwell, Chevrolet Motor Div., General Motors Corp. Diesel Engines – John MacKendrick, Clark Brothers Co.

Chicago – Nov. 10

Knickerbocker Hotel; dinner 6:30 p.m. Cooperative Research Comes of Age – C. B. Veal, manager, Cooperative Research Council.

Cleveland – Nov. 9

Subject and Speaker to be announced.

Colorado Club – Nov. 24

Eberhardt-Denver Co., 1408 West Colfax, Denver. Production of War Material – Fred Ross Eberhardt, president, Eberhardt-Denver Co.

Detroit – Nov. 16

Rackham Educational Memorial Bldg. Experiences in Actual Operations of Tanks – Colonel J. M. Colby.

Indiana – Nov. 19

Antlers Hotel, Indianapolis; dinner 6:45 p.m. Automotive Engineering Meets Tank Problems – Allan Loofburrow, Chrysler Corp.

Tractor Meeting

(Auspices of Milwaukee Section with cooperation of the SAE Tractor & Industrial Activity)

Milwaukee — **November 6**

2:00 P.M. "National Emergency (NE) Steels,"
Hyman Bornstein, Deere & Co.

3:30 P.M. "Material Substitution and Development of Engine Bearings,"
Dr. Carl E. Swartz, Cleveland Graphite Bronze Co.

6:30 P.M. DINNER. "Valves for Wartime Requirements,"
A. T. Colwell, Past President, SAE.

Milwaukee Athletic Club

Metropolitan – Nov. 19

Hotel Edison, New York; dinner 6:30 p. m. Fuels and Lubricants Meeting. Speaker to be announced.

Milwaukee – Nov. 6

Milwaukee Athletic Club. Tractor Meeting.

2:00 p.m. National Emergency Steels – Hyman Bornstein, director, Test & Research Laboratories, Deere & Co.

3:30 p.m. Material Substitution and Development of Engine Bearings – Dr. Carl E. Swartz, Cleveland Graphite Bronze Co.

6:30 p.m. dinner, Elizabethan Room. Valves for Wartime Requirements – A. T. Colwell, vice president, Thompson Aircraft Products Co.

Northern California – Nov. 10

Hotel Leamington, Oakland; dinner 6:30 p.m. Some Chemical Problems in Engine Lubrication – Robert G. Larsen.

Oregon – Nov. 13

Lloyds Golf Club, Portland; dinner 6:00 p.m. Tractor Meeting.

Peoria Group – Nov. 23

The Liquid-Cooled Engine – R. M. Hazen, chief engineer, Allison Div., General Motors Corp.

Philadelphia – Nov. 11

Engineers Club; dinner 6:30 p.m. Highway to Victory – W. J. Cumming, chairman, Vehicle Maintenance Section, Office of Defense Transportation. Engine Sleeving – D. B. Erminger, assistant chief engineer, Auto Section, International Harvester Co. Engine Temperature Control – H. L. Brownback, consulting engineer. Cold Welding – E. H. Blakelock, Quaker City Motor Parts Co.

St. Louis – Nov. 3

Parks Air College, East St. Louis. Inspection trip. Demonstrations of the Magnaflux method of inspecting highly stressed ferrous parts and of a metallizing gun.

Southern California – Nov. 13

Aircraft Engines – C. P. Sander, chief engineer, Kinner Motors, Inc.

Washington – Nov. 10

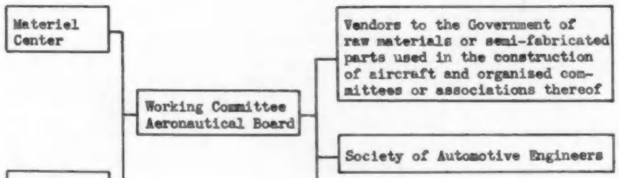
Cosmos Club, Washington, D. C.; dinner 6:30 p.m. Experience in Actual Operation of Tanks – Col. J. M. Colby. Mechanized War and the Automobile of Tomorrow – Lt. Col. G. R. Mountfort.

of other organizations which submit recommendations and comment direct to the Working Committee on proposed ANA standards:

American Standards Association
American Society for Testing Materials
American Iron and Steel Institute
American Welding Society
National Paint, Varnish, and Lacquer Association, Inc.
Rubber Manufacturers Association, Inc.
Institute of Bolt, Nut, and Rivet Manufacturers
Aircraft Cable Manufacturer's Committee
Tire and Rim Association, Inc.

In addition to the industry contacts provided through these organizations, close relations are maintained at all times with actual vendors to the government of aeronautical products through the medium of contracts.

The cooperation of industry in the development of ANA standards is generally solicited by the Working Committee rather than by either of the two services. The committee's objective in this work is to obtain the comments of as many individual producers as possible, within a minimum time, and to have this comment correlated in condensed form. If the organized industrial committees and associations outlined in the foregoing did not exist, it would be necessary for the Working Committee to circularize the industry directly with questionnaires and correspondence explaining the type of action desired. However, since the facilities of these organizations fortunately are available, and since they have developed efficient procedures for obtaining and correlating the comments of the manufacturers concerned, the Working Committee has taken and will continue to take advantage of their aid. The accompanying diagram is intended to illustrate the relationship between the Working Committee, the Services, and the industrial organizations, and to clarify the channels of contact for submission of official recommendation or requests for comment on ANA standards. This arrangement is not intended to preclude contacts being made between the aircraft industry groups (NASC and SAE) and organizations or firms included in the "Vendors to the Government" block.



Relationship between Working Committee, the services, and industrial organizations

The great majority of all contacts made with industry are directed through the NASC, SAE, or the Engine and Airplane Technical Committees of the ACCA. The question of what particular organization will be approached on any one product is determined on the basis of allocation of cognizance as explained earlier in this article and on consideration of the basic interests which will be represented in the comments received. The Materiel Center and the Bureau of Aeronautics are responsible for the general overall excellence of their respective service aircraft. The Working Committee is responsible for obtaining Army-Navy agreement and the general excellence of issued ANA standards. The SAE Aeronautics Division, when presenting the comments of the industry on proposed ANA standards, is responsible for the interests of the companies manufacturing the products under consideration. The NASC is responsible for the interests of the airplane manufacturing companies. The vendors to the government of raw materials or semi-fabricated parts are responsible for the interests of the business of manufacturing these products. The Working Committee is of the opinion that the comments of one industrial group should not be expressed and passed on to the government by a separate industrial group motivated by different interests. Since most of the ANA subjects referred to industry for comment are products of the aeronautical industry, it is usually necessary to approach only the cognizant aeronautical group. However, in the case of products of general industry which are covered by ANA standards and purchased by the aeronautical industry for use in the manufacture of airplanes and engines, the Committee prefers to obtain recommendations from both of these industries and refer them to the services for final decision. It is hoped that this rather lengthy explanation will clarify the government's position in its approach to manufacturers for comment on proposed ANA standards.

As a typical example of how the government-industry coordination procedure functions, let us trace the development of Specification AN-H-2 Hydraulic Systems; Aircraft, General Specification (Design, Installation, and Tests) issued March 28, 1942. Work on this subject began with an Army-Navy conference at the office of the Working Committee attended by representatives of the Materiel Center, Bureau of Aeronautics, Naval Aircraft Factory, and the Committee. It was agreed to prepare a general specification for design, installation, and tests, based on desirable features of the then-existing AAF Specification 27993 and Navy Specification SR-99 together with considerable new material of a technical character. It was also agreed that the procurement requirements for the various items of equipment used in hydraulic systems should be covered by separate ANA procurement specifications. There were approximately 15 such items of equipment for which ANA specifications and drawings had to be prepared. The very considerable amount of specification preparation work involved in this project was divided equally between the two ANA Specification Units, and emphasis was placed first on the general design specification. When the first draft of this specification was completed by the Army Unit, it was coordinated with the Bureau of Aeronautics and then revised. Simultaneously, work was proceeding on the procurement specifications for the equipment. The Working Committee then made arrangements with the NASC and the SAE for obtaining the comments of the industry on the general specification. Since this specification deals with design and installation requirements which are binding on the airplane manufacturers, it was a matter primarily of interest to the NASC. However, since the performance of the hydraulic system is closely linked to the characteristics of the equipment used, it was considered desirable to have the appropriate SAE subcommittee also participate in furnishing recommendations. Arrangements were therefore made to have the

NASC assume primary responsibility and to coordinate its action with SAE Subcommittee A-6 on Aircraft Hydraulics Equipment. Copies of the proposed ANA specification were furnished in quantity to the NASC for further distribution. The NASC Hydraulic's Systems and Installations Subcommittee and the SAE Subcommittee A-6 on Aircraft Hydraulic Equipment held a joint meeting, reviewed the proposed ANA specification, and prepared a set of comments and recommendations based on detail comments received from the industry at large. Immediately following this meeting a combined Army-Navy-industry meeting was held under the cognizance of the Working Committee to consider the industry's recommendations. Needless to say, the majority of these recommendations were adopted and contributed to the usefulness of the specification in a large degree. The ANA specification was then revised accordingly and issued. Following the meeting on the general specification, a second meeting was held, sponsored by the SAE Subcommittee on Hydraulic Equipment, and attended by representatives of the Army, Navy, and NASC, to review drafts of the proposed ANA specifications for the hydraulic-equipment items. Inasmuch as these specifications were not as far advanced as the general specification, final action could not be taken; however, much valuable information was furnished which facilitated further work in the specification preparation. Revised drafts of most of these specifications were later submitted to the SAE for review, and industry comment was furnished by correspondence.

The foregoing case is an example of a relatively large and extensive effort as required for a specification of such wide scope. This specification is 34 pages long, contains 10 figures and 6 tables, and references 24 applicable specifications and 41 applicable drawings. For simpler items coordination is often accomplished entirely by correspondence. Occasionally, when time is pressing, the Working Committee arranges to effect industry coordination and final Army-Navy agreement by means of a single Army-Navy-industry conference held at the office of the Committee, attended by representatives of the Army, Navy, industry organization personnel, and the manufacturers directly concerned. Whatever the means employed, the objective is the same – that is, to develop the most useful and practicable requirements for military aircraft materiel.

The aeronautical industry standardization organizations which have been participating in this coordination effort with the Working Committee have demonstrated their ability to accomplish this work effectively and expeditiously. In doing so they assume an integral share in the development of ANA standards. The Working Committee wishes to take this opportunity to express its sincere appreciation for the time and effort put forth by the hundreds of engineers engaged in this work and for the cooperative spirit of their companies in encouraging their participation. The Committee also thankfully acknowledges the initiative displayed by the SAE, the NASC, and the ACCA, in assuming responsibility for the organization and administration of this industry effort.

■ ANA Bulletins

For certain ANA products such as paints, electric cable, hydraulic packings, switches, and so on, the possible variations in design and quality and the nature of the tests are such that specific Army and Navy approval of any given manufacturer's product is required as a prerequisite to its use in Army and Navy aircraft. Approval is granted on the basis of qualification tests as set forth in ANA specifications. Until recently, the records of what specific products had been approved under any ANA specification and the procedure for disseminating this information were handled by the services, each acting independently of the other. However, to maintain true AN standardization of the actual products, it is essential that products tested and considered acceptable by one service be considered equally acceptable by the other. A system for coordinating all phases of the qualification procedure has been established under the supervision of the Working Committee.

The results of qualification tests as conducted by either service are submitted through the Committee for review and approval of the other service. Neither the Army Air Forces nor the Bureau of Aeronautics will grant qualification approval of a manufacturer's product covered by an ANA specification until both services agree that it is satisfactory for use on Army and Navy aircraft. When agreement has been obtained that the product is satisfactory, the manufacturer is so notified by the Working Committee, and the product is included in an Army-Navy Aeronautical Bulletin.

ANA Bulletins are published applicable to each ANA specification for which qualification tests are required, listing all the products which have been tested and found to be acceptable under that specification for use on Army and Navy Aircraft. The bulletins are coordinated in the same manner as specifications and issued under the cognizance of the Committee. The ANA Bulletins specifically identify each product by its model number, part number, formula number, brand name, and so on, as applicable, and by the name of the manufacturer. The fact that a manufacturer's product may be included in an ANA Bulletin does not assure him the award of any contract or the acceptance of his product under any contract. Acceptance of the product is based on the usual inspection and tests to determine conformance with the applicable specifications. It should be understood however that, when products listed in an ANA Bulletin are furnished in production quantities under contract, they will be equal or superior in all respects to the product upon which approval was originally granted.

As stated previously, the qualification test requirements for this class of product are contained in the applicable ANA specification. The specification also contains a statement urging interested manufacturers to request authorization for qualification tests of the products they propose to offer for use on Army and Navy aircraft. Heretofore the requirements of the two services relative to authorization of the tests, submittal of test samples, retests, approval, and so on, have been quite different, and diverse methods have been employed in furnishing information concerning these details. As a means of providing proper understanding of this subject on the part of industry personnel, the Working Committee has inaugurated another type of ANA Bulletin which covers the general policy for procurement and use of a particular class of product. For example, a bulletin is now being prepared covering the policy for aircraft hydraulic equipment. The purpose of this bulletin is to explain the procedure whereby manufacturers may obtain approval of the Army Air Forces and the Bureau of Aeronautics for hydraulic equipment and related products which they propose to offer for use on

Army and Navy aircraft, and thereby to facilitate the approval of as many items of satisfactory equipment and products as may be available. Nothing in the bulletin is to be construed as excluding any product from consideration for such approval. A similar bulletin covers aircraft finishing materials (paints, dopes, and so on).

The ANA Bulletins, of either class, are to be considered as publications stating information only, as contrasted to ANA specifications stating mandatory requirements. Whereas specifications are prepared and used as part of a legal contract, the bulletins are informative only and contain no requirements governing the quality of the products represented or the performance of any contract. The main purpose of the bulletins is to facilitate the application of ANA standards in the construction of aircraft.

■ Index of AN Aeronautical Standards

This index is published monthly by the Working Committee. It lists alphabetically all ANA specifications, drawings, and bulletins which have been issued, and shows the exact title, number, and date. It also indicates the number of the Navy and/or Army specification or drawing which is superseded by the ANA standard. Copies of the Index are available upon request to the Materiel Center, Army Air Forces, Wright Field, Dayton, O., or to the Bureau of Aeronautics, Navy Department, Washington, D. C.

■ ANC Committee on Design Criteria

Several years before the Working Committee of the Aeronautical Board assumed cognizance of Army-Navy standardization, the Materiel Center, Bureau of Aeronautics, and the Civil Aeronautics Administration (then Air Commerce Branch of the Department of Commerce) realized that their separate requirements for aircraft structures design resulted in unnecessary hardship and confusion for airplane designers in the industry. Individual manufacturers building airplanes for both military services and commercial customers were required to follow separate design criteria in the calculation of imposed air loads and to allow different unit stresses in the structure, although a pound is a pound and the materials of construction are identical. It was agreed that common design criteria could be developed which would be acceptable to all three agencies. Accordingly, a committee was formed, known as the ANC (Army-Navy-Civil) Committee on Aircraft Requirements, composed of technical representatives of the structures branches of the three agencies to undertake standardization of criteria for determination of external loads, internal loads, allowable loads, proof of strength by structural tests, and other subjects in this structural design field. It was agreed that this standard material would not be applied as a mandatory requirement, but rather as criteria acceptable to all three agencies, and it was made clear that other methods and procedures were also acceptable, provided they produced equivalent results or provided they were properly substantiated. Early emphasis was placed on project ANC-5: "Strength of Aircraft Elements," and a bulletin of this number and title was formally approved and published in January, 1938. This bulletin was received very favorably by the aircraft industry and has had wide circulation. Over 19,000 copies have been distributed.

Up to 1941 the ANC Committee and its various technical subcommittees functioned as an entirely voluntary activity by informal agreement between the three agencies concerned. In 1941, the Secretary of War, the Secretary of the Navy, and the Administrator of Civil Aeronautics agreed on the establishment of the ANC Committee on an official basis under the supervision of the Aeronautical Board, to coordinate the development of aircraft design criteria. The name of the organization was changed to "Army-Navy-Civil Committee on Aircraft Design Criteria." The membership comprises the Army and Navy Members of the WCAB, three representatives each from the Materiel Center and the Bureau of Aeronautics Administration. One of the Members of the WCAB, Capt. G. A. Seitz at this time, serves as chairman.

The functions of the Committee are:

(a) To develop aircraft design criteria governing: imposed loads, structural design, allowable stresses, methods of analysis, methods of testing, performance calculations, and so on, and to recommend the adoption of these criteria by the three member branches of the Government.

(b) To arrange for such studies, tests, investigations, and conferences as may be necessary for the development of these criteria.

(c) To arrange means for exchange of technical information related to these criteria between responsible personnel in the member branches of the government and for maintenance of effective liaison.

(d) To arrange for promulgation, including publication, of criteria adopted by the member branches of the government, in the form of ANC Bulletins.

The Committee meets approximately four times each year, or oftener as necessary to arrange for subcommittees to carry out assignments, and to report progress and recommendations to the member branches of the Government.

The criteria thus established are issued by the ANC Committee in the form of ANC Bulletins, under the supervision of the Aeronautical Board. Printing is accomplished by the Government Printing Office and all issued bulletins are available upon request to the Superintendent of Documents in Washington. The following bulletins are now published and available:

ANC-1(1)	Spanwise Air Load Distribution
ANC-2	Ground Loads
ANC-5	Strength of Aircraft Elements

A limited quantity of Bulletin ANC-14 Spin Requirements for Primary Training Airplanes has been released but is not yet on sale.

As in the case of AN Aeronautical standards, it is the desire of the ANC Committee that the ANC Bulletins receive the widest possible coordination with the aeronautical industry during their development. Toward this end, the technical subcommittees appointed by the ANC Committee to assemble and develop the technical data, forward drafts of proposed bulletins to the airplane companies for review and comment. The collected recommendations of the industry then receive full consideration in the final preparation of the bulletin. As a means of assisting in this coordination and for the further purpose of making available to the Government the vast amount of technical data developed by and in the engineering department files of the aircraft industry, the Airplane Technical Committee of the ACCA has enlisted the cooperation of its membership in offering pertinent data for consideration during the development of the basic bulletin material. This procedure

expedites preparation of the first draft and facilitates subsequent coordination. The time and effort expended on this work by the engineering staffs of the airplane companies has been of material assistance to the government agencies and is appreciated.

The sudden return of wood as a material in aircraft construction revealed a serious lack of published information concerning strength and design properties and up-to-date fabrication methods. In the years of intensive aeronautical development between the last war and this one, millions had been poured into metals research but relatively little in the field of wood. Recognizing the need for prompt action in providing authoritative design data and fabrication information for use by the many new companies entering the wood aircraft field, the Aeronautical Board, on March 7th of this year, approved the following program:

(1) That an ANC Handbook on the Design of Wood Aircraft Structures be prepared by the ANC Committee on Aircraft Design Criteria in close collaboration with the Forest Products Laboratory, Forest Service, U. S. Dept. of Agriculture, and issued under the supervision of the Aeronautical Board.

(2) That a Wood Aircraft Fabrication Manual, to be prepared by the Forest Products Laboratory, be issued by the Aeronautical Board.

(3) That suitable ANA procurement specifications for wood and plywood be prepared and issued by the Working Committee of the Aeronautical Board.

(4) That all of these publications be completed by July 1, 1942.

An Executive Technical Subcommittee headed by E. I. Ryder of the CAA was immediately appointed by the ANC Committee to work with the Forest Products Laboratory on the preparation of the handbook on design. Approximately 15 engineers of the FPL, under the general supervision of Messrs. T. R. C. Wilson and T. R. Truax, were engaged on this handbook and on the fabrication manual. FPL personnel visited aircraft plants throughout the country, and data were submitted by 43 different companies to supplement that available in the FPL and the military Services. These two publications and the ANA specifications were completed, printed, and issued early in July. Both the handbook on design and the fabrication manual are classified as restricted documents. They are available only to contractors to the government and other duly qualified firms upon application to the Materiel Center, Bureau of Aeronautics, or Civil Aeronautics Administration, subject to the usual restrictions on distribution of classified material.

The ANC Handbook on the Design of Wood Aircraft Structures, 177 pages, has been prepared for use in the design of both military and commercial aircraft and presents allowable stresses and methods of structural analysis and design which are acceptable to the Army, the Navy, and the CAA. The Wood Aircraft Fabrication Manual, 257 pages, provides information to assist the manufacturer of wood airplane parts in preparing materials and carrying out the operation essential to producing modern planes and parts in accordance with specifications and drawings. These two publications constitute a most useful and timely contribution to current aircraft production developments.

Supplementing its action on wood construction, the Aeronautical Board subsequently approved a parallel program to provide much needed information in the field of structural plastics for aircraft. The ANC Committee on Aircraft Design Criteria appointed an Executive Technical Subcommittee, headed by Henry Sang of the Naval Aircraft Factory, and approved a working directive to include the following:

(1) Establish a classification system for plastics.

(2) Prepare a plastics supplement to Bulletin ANC-5 to cover the properties of plastics intended for primary or secondary structure of aircraft.

(3) Prepare notes on the design and fabrication of plastics parts, recommendations regarding selection of plastics for specific applications, notes on design of parts for molding, casting, or forming from plastics by available processes, notes on joints and attachments, references to pertinent government specifications, and a bibliography for designers.

(4) Coordinate this work with plastics research work being conducted by the Forest Products Laboratory.

(5) Submit to the Working Committee of the Aeronautical Board proposed ANA specification requirements for plastics materials and for methods of testing and inspecting.

This committee has held initial meetings and has enlisted the cooperation and assistance of the existing commercial standardizing societies of the plastics industry for the purpose of assembling and developing the great quantity of data required to carry out its directive.

Joint Aircraft Committee

As stated earlier in this article, the Army and Navy Members of the Working Committee have additional duties in connection with other standardizing activities being carried on by the services. Chief among these other activities is the Subcommittee on Standardization under the Joint Aircraft Committee. The Joint Aircraft Committee (JAC), as indicated by the accompanying diagram, is composed of ranking representatives of the Army Air Forces, the Bureau of Aeronautics, Royal Air Force Delegation and British Air Commission, and the Aircraft Production Division of the War Production Board. This Committee has been functioning for more than two years. There are various subcommittees assigned to different activities, all reporting to the JAC. Among these, the one most directly concerned with the subject of standardization of aeronautical materiel is the subcommittee on Standardization (SCS). The purposes of this subcommittee are:

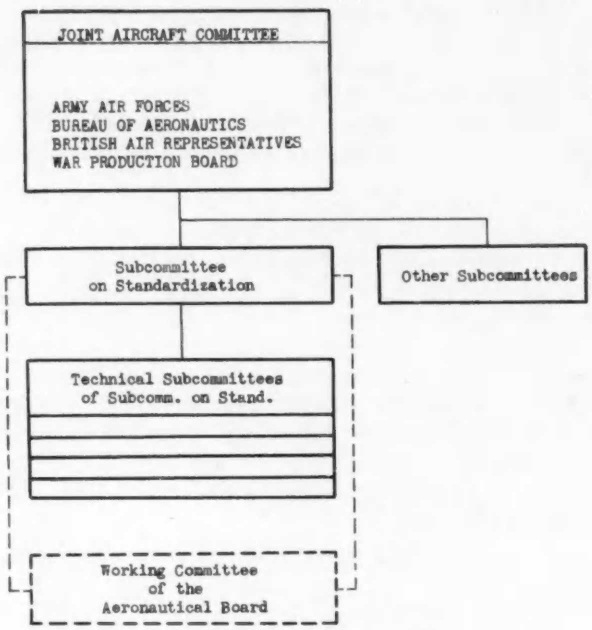
(1) To facilitate production, supply, and maintenance of aircraft produced in the United States for the allied forces.

(2) To standardize aircraft and aircraft components of two or more services, in so far as practicable.

(3) To improve aircraft through interchange of engineering information and developments resulting from experience and tactical operations.

The membership of this subcommittee is composed of technical representatives of the Army Air Forces, Bureau of Aeronautics, British Air Commission, and WPB. T. P. Wright of the Aircraft Production Division, WPB, now serves as chairman. The subcommittee meets on regular schedule, all meetings being held in the office of the Working Committee of the Aeronautical Board. Detail studies and recommendations relative to standardization problems concerned with individual aircraft components and other items are prepared by technical subcommittees, of which there are now approximately 21, and are referred

to the Subcommittee on Standardization for approval and further recommendation to the JAC. Again, as in the case of the JAC and the Subcommittee on Standardization, most of the technical subcommittees are composed of representatives of each of the using services and the WPB. Meetings of the technical subcommittees are held only as required,



Joint Aircraft Committee relationship with Working Committee of the Aeronautical Board

and usually at the office of the Working Committee of the Aeronautical Board.

It should be pointed out that the Joint Aircraft Committee and its Subcommittee on Standardization generally function independently of the Aeronautical Board and its Working Committee. Coordination between the two activities is provided by a partial degree of interlocking membership, and through established procedures whereby certain subjects may be referred from the (SCS) to the WCAB for appropriate action. Both the Army and the Navy Members of the WCAB are also members of the SCS. Col. Lingle as the Recorder of the SCS maintains a staff known as the Office of the Recorder, housed in the WCAB office. Whereas the WCAB actually prepares, prints, and issues specifications, drawings, and other ANA documents, the SCS is strictly a reviewing and deciding body, and has no facilities for preparation and issue of standard documents other than its minutes and reports. Consequently, when an item has been standardized by the SCS and it is considered desirable that the item be covered by a standard document, the subject is then referred to the WCAB for preparation of a suitable ANA specification or drawing. In certain cases, the SCS may simply agree that a particular item should be standard for procurement and use, and forthwith refer the entire matter to the WCAB for development of the standard requirements and issuance of ANA specifications. In such cases, the WCAB assumes permanent responsibility for the subject, and further coordination is arranged under the cognizance of the Working Committee. From the foregoing, it may be seen that, although the functions of the SCS and the WCAB are separate, their main objective, that is, standardization of aeronautical materiel, is identical, and their activities are arranged to supplement one another in attaining this objective. The accompanying diagram illustrates the connection between the Working Committee of the Aeronautical Board and the Subcommittee on Standardization under the Joint Aircraft Committee.

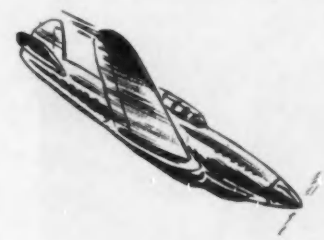
■ Conclusion

In reviewing the foregoing outline of the AN standardization effort as applied to the development and issue of ANA specifications and drawings, the reader may ask: "What is the basic purpose?" An answer to this question is found in the following extract of a recent statement by Lt.-Gen. Brehon B. Somervell, Commanding General of the Services of Supply, relative to the general industrial war effort: ". . . the greatest need has been and still is for a more comprehensive program of equipment standardization and simplification." The need for AN standardization is manifested by a wide variety of specific problems originating both within the services and in the producing industry. The basic objective common to all these problems is expressed by the single factor, "efficiency." This means overall efficiency in the production and the use of military aeronautical materiel.

The further question arises: "How do the ANA standards contribute to this efficiency?" Since the standards benefit both fields, production and use, the answer is twofold. With reference to production, the ANA specifications provide joint requirements applicable to both Army and Navy aircraft. The advantages of this feature are evident. It enables the manufacturer to purchase and stock common materials, to establish a common production line, with uniform tooling, to use common processes, and to conduct inspection by a uniform system for both services. It speeds production and increases the overall output.

However, the most direct and potentially critical advantages of AN standards are realized in the field of actual operation of military forces, including all phases of such operation. The standards facilitate government procurement. By reducing the necessary variety of spares they conserve valuable shipping space and simplify and reduce the stocking problem in the immediate theater of action. Finally, they provide that degree of parts interchangeability which may mean the difference between having a plane in the air fighting the enemy or helpless on the ground for lack of a replacement for some damaged special part. AN standardization helps to "keep 'em flyin'."

Aeronautical Engineering Contributions by Nations



T. P. WRIGHT, speaking before the Metropolitan Section meeting, Sept. 17, in New York, credited aeronautical engineers of several nations with notable "firsts" in developments, and "furthests" in carrying some development into practical use. Among his citations were:

ENGLAND: For the successful development at an early stage of the war of the **Multi-gun Fighter;**
Power-operated Turrets, and
Rolls-Royce **Liquid-cooled Engine.**

GERMANY: An exceptional job in developing **Fuel Injection** for engines;
Techniques of **Dive Bombing** tactics in cooperation with ground forces, and
Tremendous **Importance of Air Power** to any country.

UNITED STATES: Design and most efficient **Cargo and Transport Planes** in the world;
Conception and development of the **Four-engine Bomber;**
Precision Bombsight used with the high-altitude bombers we developed;
Turbo Supercharger;
The National Advisory Committee for Aeronautics **Cowl;**
Flap developments of several types – such as the Fowler;
Controllable pitch, constant speed propeller; and the
High-powered, extremely reliable, **Air-cooled Engine.**
Our Naval Aviation first brought out the **Dive Bombers,** he pointed out.

BOX SCORE

U. S. vs. Enemy Aircraft

IN RECENT encounters (Aug. 1 – 29):

American P-40's shot down 13 Jap Zeros and four bombers, confirmed with the loss of two P-40's. **Ratio – 8:1 in our favor.**

Our P-39's shot down 13 Zeros, confirmed, five probables, for a loss of 4 P-39's. **Ratio – 4½:1 in our favor.**

In one engagement alone (Aug. 23, over Port Darwin, Australia) our P-40's attacked 47 Japanese planes – 27 bombers and 20 Zeros. Eight Zeros and four enemy bombers were shot down without a single American loss. **Ratio – 12:0 in our favor.**

During last week in August, for all Army plans in all theaters of combat: Forty-one enemy planes destroyed, 23 probably destroyed, and six damaged, for total casualties of 73, as compared to one U. S. Army plane destroyed, three missing, and three damaged, or a total of seven casualties. **Ratio – 10:1 in our favor.**

Total score (Feb. 1, 1942, to Aug. 30) Japanese planes destroyed by the U. S. Army *in the air,* 234 as against 109 American planes lost. **Ratio – 2.3:1 in our favor.**

Gen. Chennault's American Volunteer Group operating in China resulted in 218 Japanese planes destroyed compared with 84 AVG losses. **Ratio – 2.6:1 in our favor.**

U. S. Flying Fortresses in Europe in 13 daylight raids marked up a new record for bombers in aerial combat, with 21 attacking enemy planes shot down, confirmed, and 26 were probably destroyed as against the loss of only two Flying Fortresses. Ratio of confirmed losses – 10:1 in our favor.

"Newspaper and radio commentators are far too prone to select one particular item of aircraft performance in which some enemy plane excels, and therefrom draw the conclusion that the plane as a whole is better than ours.

" . . . Aeronautical engineering is the art of compromising to best advantage the conflicting items of design so as to create a fighting plane which can be successful in combat.

"Generally speaking, speed and climb are in conflict and both conflict in requirements for load carrying and long range.

"It is difficult to obtain maximum performance characteristics at any one altitude; therefore, if a plane is designed to fight at a specific altitude, it is likely to be inferior to some other plane at some other altitude.

"Similarly, maneuverability is in conflict with protective equipment as the addition of armor and leak-proof tanks, by adding weight, lessens maneuverability. But our experience shows that this weight is well spent. A notable example: Our P-40's versus the Japanese Zero."—T. P. Wright, Deputy Director of Aircraft Production, War Production Board.

Plastics Will Delight Post-War Car Designers

▪ Washington

Peering into the future on the post-war car, at the Oct. 13 meeting of the Washington Section, Capt. A. C. Radebaugh visioned automobiles of tomorrow as something on which the designer "can really go to town" with plastics. In a few years, Capt. Radebaugh prophecied, in his talk on the "Car of Tomorrow," the public may be riding in cars with plastic panels and windows, and even plastic tops. The use of plastics will make cars lighter, quieter, better insulated, and easier to air condition; windows will be truly shatterproof. Looking at the car from an appearance angle, there will be no body paint and, therefore, no paint fading and chipping, he said. Because plastics quite lend themselves to molding, tomorrow's car may have crystal-clear, curved windshields and transparent or translucent roofs shaped into various designs.

Capt. Radebaugh emphasized the fact that he is interested in plastics from the standpoint of an industrial designer, and not from that of an engineer or chemist. The real growth in the use of plastics, he related, began in the middle thirties, and the growing need for substitutes has created an important impetus in the use of plastics. "We are really witnessing a transition from a steel age to a plastic age," he said, and the acceptance of plastics by the public will make their increased use by the automobile industry – already the greatest plastics user of industrial groups – an easy problem.

With the present break in automobile production, the automobile manufacturer has a golden opportunity for a new start after the war, and the public will have something really new in cars, Capt. Radebaugh believes.

A Repeat Performance for Mitsubishi Kinsei Engine

▪ Indiana

William G. Ovens, staff engineer of the Wright Aeronautical Corp., Paterson, N. J., presented his paper, "Some Notes on Design Features of the Mitsubishi Kinsei Engine," when he spoke at the Indiana Section's Sept. 17 meeting at the Antlers Hotel in Indianapolis. The entire text of the paper and pictures were published in the July issue of the SAE Journal (Transactions Section, pp. 253-266). Mr. Ovens' talk drew a crowd of over 300. The speaker illustrated his paper with numerous slides and three long tables of a display of the engine parts.

Automotive Civilians Help Out for Duration

▪ Northwest

Following the Army Carolina maneuvers in 1941, a special committee headed by John D. Hertz made an extensive survey for the War Department of the mechanical problems involved in the field operations of motorized equipment, W. W. Churchill, automotive consultant for the War Department, told the audience at the Northwest Section's first meeting of the current season on Sept. 3. In his speech titled "Civilian Automotive Instructors in the U. S. Army," Mr. Church-

Cab Dimension Group in Action

Meeting of T&M Committee on "Minimum Cab Dimensions," Sept. 28, at SAE Headquarters, New York. This is one of the 30 transportation & maintenance committees which are working on war assignments for the Office of Defense Transportation. (Left to right): A. F. Hickman, Hickman Pneumatic Seat Co., Inc.; J. Willard Lord, Atlantic Refining Co.; K. W. Birkin, Sinclair Refining Co.; C. E. Edwards, Mack Manufacturing Co.; D. A. Dobson, General Ice Cream Co.; R. A. Hess, Chairman, Standard Oil Co. of N. J.; C. M. Bigelow, Brockway Motor Corp.; F. E. Carlsen, Hoffman Beverage Co.; L. R. Gwyn, Jr., Railway Express Agency, Inc.; F. Kohlberger, Mack Mfg. Co.; R. M. Werner, United Parcel Service; R. J. Whitley, Socony-Vacuum Oil Co., Inc. Those absent were: S. M. Kimball, Shell Oil Co., Inc.; E. R. Nylander, Baker Equipment Engineering Co.; E. W. Otto, Standard Oil Co. of N. J.

ill explained that many automotive engineering and maintenance problems confronted the Army following the experiences in Carolina and other places, and it was recommended that civilian help should be given.

To meet this need, a group of about 400 automotive consultants was selected, a program formulated and set in motion last January, and a course for officers was held, at which the consultants were present. When the "school" was started many doubted its value, but when the course was over a large percentage of officers realized the advantages of it.

Mr. Churchill briefly described the system followed by an applicant who wishes a civilian consultant position.

Under the present program the consultants cannot be taken out of the United States, declared Mr. Churchill. They may be transferred with proper permission, he added, and when in service the automotive officer may change their rating.

Cu and Fe Alloys Are Today's Problems

▪ *St. Louis*

In a speech entitled "Material Supply During Wartime," presented by Harry Scott of the Union Electric Co., at the St. Louis Section's Oct. 6 meeting, Mr. Scott said that "the demand for copper and steel present the two big problems of today." Although the United States is the largest producer of copper in the world, he pointed out, in pre-war days we imported some of this material.

In 1941 manufacturing facilities were inadequate for the emergency, Mr. Scott disclosed, but due to government promotion of the expansion of plants and building of new ones we now have ample manufacturing capacity, with the exception of rubber.

Mr. Scott told the audience that the priority system actually began during the last war, but it has now been very greatly expanded. For example, he pointed out that while a year ago about 35,000 PD1A applications had been filed, early this month application number 1,529,000 was filed.

About 3,000 government employees are now trying to control 30,000 manufacturers, Mr. Scott noted, and in his opinion this number is inadequate to exercise sufficient control.

Scope of T&M Activity War Work Is Boundless

▪ *Mohawk-Hudson Group*

The Transportation and Maintenance Activity of the SAE held the spotlight at the Mohawk-Hudson Group's (formerly Capital District Group) first meeting of the season on Sept. 29. Henry Jennings, SAE Staff Representative for the T&M Activity, talked on "The SAE At War." The meeting was held at the De Witt Clinton Hotel in Albany, and a dinner preceded the meeting. The following officers were installed: Austin M. Wolf, chairman; D. K. Wilson, vice chairman; and Bruce Crane, secretary-treasurer.

Mr. Jennings told the story of the SAE Transportation and Maintenance Activity in war work. Early in 1941, he pointed out, the T&M Activity undertook a comprehensive program which was designed as a research effort to answer serious problems confronting the various fields of motor vehicle operation and maintenance. At that time, Special Utility Problems, Maintenance Control and Research, Fleet Management Problems, Equipment and Design Factors, and Special Bus Problems were considered.

When John L. Rogers, Director of the Division of Motor Transport, asked the Society for formulation of an SAE group to act in cooperation with the Maintenance Section of the Office of Defense Transportation's Division of Motor Transport, the SAE T&M Activity Committee named a special Motor Vehicle Maintenance Coordinating Committee to perform that function. This coordinating committee, fortified by 30 special committees working under its direction, immediately started to carry out the necessary research and analytical work, and to concentrate the whole T&M Activity program on this important war effort.

Progress Is Rapid

Since that time many reports have been completed, and many others are well on their way to being finished.

Committee 17, "Standard Practice Instructions," for example, started out to make some recommendations for the presentation of maintenance instructions for use by mechanics when they are actually performing maintenance operations, and for training new men either in shop or school. The committee hopes that its recommendations will be followed by some of the producers of maintenance instructions.

The committee's procedure was somewhat as follows: The manufacturer members of the committee produced samples of Standard Practice Instruction. The next time the committee met everyone on the committee was given the opportunity to criticize the samples. If a piston-ring manufacturer member could not understand the instructions of a brake manufacturer, they were revised. The result of this committee's thorough work is a set of specifications for Standard Practice Instructions, Mr. Jennings told the audience. These specifications, the Committee feels, are necessary and may well be followed by any manufacturer who makes a product complex enough in its use to require instructions. These specifications have been approved and adopted by the Society as SAE Recommended Practice.

Discusses Metal Coating

"Another committee that is very interesting," the speaker continued, "is Committee No. 6, 'Metal Coating-Applications and Technique.'" Brake drums was the first item the committee tackled. Worn-out brake drums were machined for metal spray application. This turned out to be quite a problem, since preparation for spraying is the most important part of the process and the project consisted of developing a *new* technique because heretofore metal spraying had been unsuccessful on brake drums. "The job would have been easier," he said, "if the Committee were willing to use special equipment, but since they were developing a process for fleet or repair shop operation, they felt it was necessary to find out how to do the job on a regular brake drum lathe." After many hours of work, they succeeded in doing the job with the type of equipment transportation and maintenance men have available.

Today the subjects investigated by the T&M Activity have reached the total of 30, the speaker said.

American automotive engineers man the longest battlefront of World War II – a battlefront which stretches from New York's 39th Street around the globe, Mr. Jennings told the audience. The committees which meet at the 39th Street SAE headquarters, or in one of the cities where the Society has a Section, or at any other industrially important point, may well be the ones responsible for the decisions and progress and development which will result in the achievement of an objective of a task force on the other side of the globe. This war is a war, he said, wherein battles actually may be won tomorrow as a result of yesterday's engineering conferences; by equipment created by American engineering brains, and built here in America — designed, created, and built just a little bit better . . . a little bit faster . . . and a little bit more . . . than those of our enemy.

Urges Competence In Canada's War Job

▪ *Canadian*

The initial dinner meeting of the season attracted 77 members and guests of the Canadian Section to the Hamilton Golf and Country Club at Ancaster, Ont., on Sept. 18. The dinner meeting was preceded by an informal golf tournament.

Alexander Gray, president of Gray Forgings & Stampings, Ltd., the Canadian "Will Rogers," was guest-of-honor speaker. He chose as his subject "The Impact of War on the Automotive Industry." Mr. Gray drew parallels between some recent governmental executive orders and the fantastic ordinances which Swift's Gulliver discovered in the mythological land of Lilliput.

He discussed the tightening and multiplying controls, allocations, and restrictions which to an unprecedented degree are regimenting industry in Canada. He said, for example, that his company was subject to an order which prohibits the retention on its premises of scrap in excess of a stipulated weight . . . That stipulated weight of scrap is produced *hourly,* he added, by his plant's war-work manufacturing.

He concluded his address with a declaration that whatever the "shape of things to come," economically, the men of vision, the men of technical ability, the men of enterprise, industry and managerial competence should and shall direct productional effort.

'Split Engine' Principle Has Its Pros and Cons

▪ *Chicago*

Whether or not the "split engine" principle of operating half the cylinders on a car while the other half goes along for the ride provides a definite answer to the gasoline rationing headache that is about to afflict everyone, is a question that carries with it many ifs, ands, and whys. However, engineers are doing a masterful job of dissecting and testing for the right answers, as evidenced by the presentation of a paper on "Increased Economy with Fuel and Tire Rationing" by Emil O. Wirth, chief engineer, and Albert H. Winkler, research engineer, Bendix Products Division, Bendix Aviation Corp., South Bend, at the Oct. 13 meeting of the Chicago Section.

"Loss of acceleration and power in the 'split engine' are offset by impressive gains in fuel economy, as shown in both laboratory and road tests," Mr. Winkler, the speaker of the evening, pointed out. Cold weather starting, however, is a definitely serious problem in the split engine, he declared.

The acceleration characteristics of a "split" eight-cylinder engine, he pointed out, are not as objectionable as regards smoothness of operation as on a "split" six-cylinder engine, but the per cent increase in time to accelerate from 10 mph to 50 mph, is still approximately 243 per cent of standard. When accelerating from 10 mph to 30 mph, the time is reduced to 207 per cent of standard. Translated into time elapsed to accelerate from 10 mph to 30 mph in high gear, it would require 20.8 per cent or approximately 3.75 sec longer than the standard engine, Mr. Winkler emphasized.

Fuel economy as high as 20 per cent was obtained in road tests, Mr. Winkler said, but because of greater shifting and tendency to slip the clutch under traffic conditions, higher maintenance costs, he said, seem definitely assured with the split engine principle.

"Where constant speed operation can be assured," the speaker said, "the split engine offers impressive fuel savings, as proved by tests, but such conversions of the standard type of six or eight-cylinder engine represent only a compromise at the loss of performance and operating ease in an effort to travel farther on a given quantity of fuel."

Section Chairman J. Howard Pile introduced the new Board of Governors and guests at the speakers table - Ben Wright of the Chicago Automobile Trade Association, who spoke briefly; Gordon McDermott of the Chicago Rationing Board; and Karl M. Wise, director of engineering of the Bendix Products Division, South Bend. The Bendix organization sponsored a social half hour preceding the dinner.

Prepare for Annual Debate

▪ *Oklahoma University*

Efforts of the Student Branch at the Oklahoma University are being directed to preparations for the annual debate to be held at the Fuels and Lubricants Meeting in Tulsa on Oct. 23. Their opponents will be from the Student Branch at Oklahoma A.&M. College.

A display of SAE literature – illustrating the scope of the Society – was set up in the Mechanical Engineering Laboratory at the Sept. 24 meeting. Information cards were distributed, and a free membership to the Society was awarded to the owner of the card drawn.

Guest Speakers Reign at Meeting

▪ *SAE Club of Colorado*

The Sept. 29 meeting of the SAE Club of Colorado, Denver, was abundant with guest speakers. Kenneth G. Custer spoke on belt development; Douglas Chalmers discussed the synthetic picture as a whole; L. A. Patterson talked on the different types of hose as related to aircraft; and George Popt discussed synthetic tires, and reduced mileage and retreading in connection with tires. Open discussion on these subjects was held following the speeches.

Meet on Steering Maintenance

Meeting for the first time, on Sept. 17, Transportation & Maintenance Committee on "Steering Maintenance," began putting together its report, based on the material produced by individual Committee members. This is one of the 30 SAE-T&M groups functioning on assignment from the Office of Defense Transportation.

Seated, left to right: Gordon C. Stancliffe, General Ice Cream Co.; F. H. Davis, Ross Gear & Tool Co.; J. I. Stacey, New York Power & Light Corp.; Byron S. Snowden, General Ice Cream Co., Chairman of Committee; D. K. Wilson, New York Power & Light Corp., member of the T&M Coordinating Committee; R. H. Clark, Consolidated Edison Co. of N. Y., Inc.; H. I. Nichol, N. Y. State Electric & Gas Corp.; Edward L. Tirrell, Triple Cities Traction Corp.; Louis G. Schlosser, Brandt & Chapman Co. Those absent were: Will Dammann, Bear Manufacturing Co.; Fred W. Parker, Jr., Timken-Detroit Axle Co.; L. G. Reid, Lee Tire & Rubber Co.; G. M. Sprowls, Goodyear Tire & Rubber Co.

About SAE Members

ELBERT E. HUSTED has become president of the Titeflex Metal Hose Co. of Newark, N. J. Mr. Husted joined the company in 1924, and at first served in various departments in the factory. He was successively sales manager and vice president, and

Elbert E. Husted

in 1938 was made general manager. Before joining Titeflex, Mr. Husted's work was of an engineering nature in gold deposit survey in the Yukon, Alaska. During World War I he served in France as a captain with the AEF and remained with the Army of Occupation. Mr. Husted has held the rank of lieutenant-colonel in the U. S. Army Reserve Corps.

HARRY L. TRAPP is service manager of Frontier Pontiac, Inc., Fort Worth, Tex., having left a similar position with the Downtown Chevrolet Co., Tulsa, Okla.

WALTER C. EBERLY has joined the staff of Jack & Heintz, Inc., Bedford, Ohio, as machine and tool designer. Mr. Eberly had been special machine designer, Thompson Products, Inc., Cleveland.

The Weatherhead Co., Cleveland, is the new company connection of **W. V. PRINCE,** plastics engineer. He left Acrotorque Co., also of Cleveland, where he was project engineer.

EDWIN C. SANDHAM, formerly experimental engineer, Dow Chemical Co., Midland, Mich., is chief engineer and assistant manager, Meta-Mold Aluminum Co., Cedarburg, Wis.

LESLIE PEAT, technical writer and industrial analyst, has been named managing editor of the SAE Journal, **NORMAN G. SHIDLE,** executive editor, announced shortly before Oct. 1.

Formerly mechanic with MacKenzie Air Service, Ltd., Edmonton, Alta., Canada, **DONALD FREDERICK NASH** holds a similar position with Canadian Pacific Airlines, Municipal Airport, Edmonton.

C. F. JONES is project engineer in the Spring Division of the Borg-Warner Corp., Bellwood, Ill. Mr. Jones had been designer in charge of engine drafting, the Perfect Circle Co., Hagerstown, Ind.

O. L. BRYAN has severed his connection with the Goslin-Birmingham Mfg. Co., Birmingham, Ala., where he was a designer, and is now in the engineering department of North American Aviation, Inc., Dallas, Tex.

Formerly development engineer, Fisher Body Division, General Motors Corp., Detroit, **T. F. BRACKETT** is now with the Emerson Electric Mfg. Co., St. Louis, Mo.

E. V. RIPPINGILLE, general manager of the Research Laboratories Division of General Motors, was appointed to the Board of Water Commissioners, Detroit.

JOHN WILKINSON GRAHAM, special representative for the Union Oil Co. of Calif., and formerly located in Vancouver, B. C., has been transferred to the Head Office Export Department of the company at Los Angeles. Before his Vancouver assignment he was sales representative of the company at Durban, South Africa.

Formerly with the Fairchild Aircraft Division, Fairchild Engine & Airplane Corp., Hagerstown, Md., **RICHARD C. GAZLEY** has left this company to join the Porterfield Aircraft Co., Fort Smith, Ark., as engineering manager.

Transfer of **J. E. D. McCARTY,** Simmonds Aerocessories, Inc., recently took place. He was switched from the Simmonds-Benton Mfg. Division at Vergennes, Vt., to the Long Island City, N. Y. office of the company.

MARSHALL MONTY is an automotive specialist, War Department, Ordnance Tank and Automotive Center, Technical Unit, Detroit. He had been spare parts expert, Office of the Quartermaster General, Motor Transport Division, Washington.

ARCH L. FOSTER, for the past two years affiliated with the Phillips Petroleum Co., Bartlesville, Okla., as special assistant to the manager of the patent department, has joined the staff of *National Petroleum News* heading its refining technology and petrochemistry departments. His headquarters will be in Tulsa. Prior to joining the Phillips Petroleum Co., Mr. Foster had for 10 years been technical editor of *National Petroleum News*. A member of the SAE since 1934, Mr. Foster is secretary-treasurer of the SAE Southwest Group.

An SAE member for 22 years, **DR. ROBERT E. WILSON** has been selected to receive the Perkin Medal of the Society of Chemical Industry for 1943, which is awarded annually for outstanding work in applied chemistry. The medalist is selected by a committee representing the five chemical societies in the United States. He is president of Pan American Petroleum & Transport Co.

GEORGE H. HUFFERD has joined the staff of the Houde Engineering Division of the Houdaille-Hershey Corp., Buffalo, N. Y., as development engineer.

"Gasoline – Past, Present, and Future," delivered by **DR. GRAHAM EDGAR,** director of research and vice president of the Ethyl Gasoline Corp., New York City, was recently published as the 1942 Edgar Marburg Lecture by the American Society for Testing Materials.

Ohio State University graduate **CHARLES A. MELTON** is in the Ordnance Department of the U. S. Army, 8th Armored Division, Maintenance Battalion, Fort Knox, Ky.

J. W. BRIDWELL has been promoted from assistant chief engineer to the position of chief engineer, and was transferred from the Caterpillar Tractor Co., Peoria, Ill., to the Caterpillar Military Engine Co., Victory Ordnance Plant, Decatur, Ill.

Formerly junior mechanical engineer, U. S. Army Air Corps, Detroit, **WILLIAM A. ST. GERMAIN** is now experimental engineer in the research laboratories of the Air-cooled Motors Corp., Syracuse, N. Y.

ALEXANDER KURTI is employed as designer at the Autoyre Co., Oakville, Conn. He had been a designer with the Riley Stoker Corp., Worcester, Mass.

CHARLES B. ROSENBERG, who had been research engineer of diesel fuels and lubricants, the Pure Oil Co., Chicago, is now on the teaching staff of the School of Engineering, Swarthmore College, Swarthmore, Pa.

Formerly assistant professor of Machine Design of Wayne University, College of Engineering, Detroit, **S. J. CHENEY** has joined the Triangle Engineering Co., also of Detroit, as design engineer.

WALTER VAUGHN, who had been fuselage group engineer, Vega Aircraft Corp., Burbank, Calif., now holds the position of chief draftsman, American Aviation Corp., Jamestown, N. Y.

Formerly manager of Standard Equipment Sales, the Wilkening Mfg. Co., **WARREN K. LEE** has been elected vice president of the company, and will continue to be head-

Warren K. Lee

quartered in Detroit. Mr. Lee has been a member of the Wilkening organization for over 10 years. During World War I he served as a lieutenant in the Army Corps of Engineers.

Promotion of executives in the Bendix Aviation Corp.'s new set-up includes several SAE members. **CHARLES MARCUS,** former group executive over eastern divisions, has been made vice president in charge of engineering throughout the company; **D. O. THOMAS,** former western group executive, to the position of vice president of manufacturing in all Bendix plants from coast to coast; **MALCOLM P. FERGUSON,** former general manager of Bendix Products Division, South Bend, Ind., vice president and group executive of the western group; **RAYMOND P. LANSING,** formerly general manager of Eclipse Aviation and Pioneer Instrument Division at Bendix, N. J., was appointed vice president and group executive in charge of eastern divisions. **ARTHUR E. RAABE,** former sales manager of Eclipse Aviation, becomes assistant general manager of Eclipse-Pioneer.

Functional realignment of the executive staff of Bendix Aviation Corp., recently announced, involves several SAE members. Upper left, Charles Marcus, now in charge of all the corporation's engineering; upper right, D. O. Thomas, vice president in charge of manufacturing at all Bendix plants. Lower left is Vice President Raymond P. Lansing, and at lower right is Vice President Malcolm P. Ferguson, group executives of the eastern and western operations of the corporation, respectively.

JAY R. JAMIESON is temporarily with the War Department, Ordnance, Arlington, Va., as mechanical engineer. He had been doing experimental engineering work at the Cleveland Pneumatic Tool Co., Cleveland.

R. W. LOHMAN left the Lake Washington Shipyards, Kirkland, Wash., where he was electrical engineer, to join the Puget Sound Navy Yard, Bremerton, Wash., as senior physicist.

HOWARD L. WILLETT, JR., is chief civilian automotive adviser, the 94th Division, Fort Custer, Mich. He was formerly chief of maintenance and supplies, Willett Co., Chicago.

WILLIAM A. CRESSWELL, JR., who had been analytical engineer at the Lycoming Division of The Aviation Mfg. Corp., Williamsport, Pa., is now associate automotive engineer in the Signal Corps Radar Laboratory, Camp Evans, Belmar, N. J.

J. CURWEN ROLLO has completed his work in Nova Scotia at Clark Ruse Aircraft, Ltd., and has joined the Engineering Department of Noorduyn Aviation, Ltd., Montreal, Que.

WILLIAM R. CUBBINS, JR. has been transferred from the U. S. Army Quartermaster Corps, Production and Expediting Division, Motor Transport Service, Detroit, to the Ordnance Department, Motor Transport Service, the same city. Mr. Cubbins is a senior production analyst.

Formerly purchasing agent for the Raytheon Mfg. Co., Watertown, Mass., **WILLIAM F. MAGUIRE** has joined the Springfield Machine & Foundry Co., Inc., West Springfield, Mass., as procurement director. He is in charge of directing purchasing, priorities, and subcontracting.

EDWARD C. STEINER is no longer assistant project engineer of the Wright Aeronautical Corp., Paterson, N. J., having left this position to become general supervisor of machine parts production, Douglas Aircraft Co., Inc., Oklahoma City, Okla.

Transfer of **CURTIS EUGENE LUNDBLAD** from the Air Corps Technical School at Chanute Field, Ill., to the Air Corps Technical School at Goldsboro, N. C., recently took place. His position has been changed from that of assistant senior instructor to senior instructor of the Aircraft Engine Operation and Test Branch.

WILSON G. WALTERS recently left his position of engineer of test and design, the Sterling Engine Co., Buffalo, N. Y., to become a member of the experimental test department, Chevrolet Aviation Engine Plant No. 1.

RICHARD G. HORSCROFT, formerly in charge of the heating and ventilating laboratories of the Schwitzer-Cummins Co., Indianapolis, has been transferred to the research staff of the Automotive Division, where problems are encountered concerning tanks, jeeps, fans, pumps, and superchargers. His work includes development of formulas and normographs arising from a program of fluid-flow research outlined by SAE member **KURT A. BEIER,** chief engineer, and conducted by another SAE member, **HERBERT H. SCHULDT,** laboratory engineer.

HARRY P. DOBROW, associate automotive engineer, Industrial Service, Tank and Combat Vehicle Division, Ordnance Depart-

ment, has been shifted from Washingon to the Ordnance Tank Automotive Center, Detroit.

Transfer of **HARRY BURKHARD,** from the Newark office of the White Motor Co. to their New York office recently took place. Mr. Burkhard is in the National Account Sales Department.

Formerly with Curtiss-Wright Corp., Columbus, Ohio, **M. LE ROY STONER** now holds the position of standards engineer with GM's Eastern Aircraft Division at Linden, N. J.

WALTER F. KARR, who had been sales engineer for the Fafnir Bearing Co., Cleveland, has been transferred to the New Britain, Conn., office of the company.

GEORGE E. REYNOLDS has been promoted from district manager to vice president, the Marmon-Herrington Co., Inc., Indianapolis.

JOHN ARTHUR LAWLER, who had been designing engineer of aircraft motors, Lycoming Division of The Aviation Corp., Williamsport, Pa., has joined the AiResearch Mfg. Co., Inglewood, Calif., as engineer.

TP Vice President

Service Manager Is Promoted

TOM O. DUGGAN, general manager of the service division of Thompson Products, Inc., Cleveland, has been elected a vice president of the company, it was announced by **F. C. CRAWFORD,** president. The promotion, Mr. Crawford said, is in recognition of outstanding creative, merchandising, and executive services. Mr. Duggan joined Thompson as service division merchandising director in 1931, and was made general manager of the division in 1936. He will continue to direct the activities of that division.

Formerly chief inspector, the Stinson Aircraft Division, Vultee Aircraft, Inc., Wayne, Mich., **ELDRED H. HUFF** has taken a position as works manager with the Howard Aircraft Corp., St. Charles, Ill.

PAUL P. BAUERNSCHMID has left his position of chief designer with the Chandler-Evans Corp., South Meriden, Conn., and is now connected with the Waterbury Tool Division of Vickers, Inc.

E. A. LONGENECKER, president, Lauson Division, Hart Carter Co., New Holstein, Wis., and **HAROLD A. TODD,** president, Wisconsin Motor Corp., Milwaukee, Wis., are two of the 11 members of the new industry advisory committee of the Industrial Internal-Combustion Engineering Section, Construction Machinery Branch, War Production Board. **GEORGE H. CHERRY,** formerly with the American Bosch Corp., Detroit, is chief of the Section.

W. A. BLUME, president, American Brakeblok Division, American Brake Shoe & Foundry Co., has been appointed a member of the Plastics & Synthetic Rubber Section, Chemicals Branch, War Production Board.

ELMER A. CLARK, vice president of Budd Wheel Co., Detroit, and **FRANK B. WILLIS,** director of sales, Bendix Products Division, Bendix Aviation Corp., South Bend, have been named members of the Chassis Parts Subcommittee, Automotive Replacements Parts Section, Automotive Branch, War Production Board.

GEORGE D. McCORMICK has changed his company connection from the National Carbon Co., Inc., New York City, where he was technical representative, to the engineering department of Continental Motors Corp., Detroit.

Appointment of **WILLIAM A. M. BURDEN** as special assistant to the Secretary of Commerce in matters relating to the Civil Aeronautics Administration has been announced. Mr. Burden was transferred from the Defense Supplies Corp., where he has been vice president in charge of the division of American Republics Aviation.

DR. F. H. GARNER, formerly chief of laboratories, Esso European Laboratories, London, England, has joined the University at Birmingham, England, as a professor of Oil Engineering and Refining.

SAE Past President **WILLIAM B. STOUT,** president of Stout Engineering Laboratories, Inc., Detroit, has been appointed to the board of consultants for the smaller war plants division of WPB.

RALPH C. LEWIS, engineer and owner of Development Engineering Laboratories, Detroit, has combined his engineering service with his manufacturing activities in the Lewis Superheaters factory, also in Detroit.

MALCOLM C. MORRISON is a member of the Ordnance Department, Tank and Automotive Center, Engineering Division, with headquarters in Detroit. He had been a civilian engineer in the U. S. Army Quartermaster Corps, Holabird Motor Base, Baltimore, Md.

After having been with Eclipse Aviation, Division of Bendix Aviation Corp., Bendix, N. J., for more than seven years, **D. J. DESCHAMPS** has severed his connections with this company to go into business for himself. Since entering the employ of Eclipse,

D. J. Deschamps

Mr. Deschamps has been in charge of the development of fuel injection equipment, and about a year ago he was made chief hydraulic engineer. The new company, Deschamps Fuel Injection Corp., New York City, develops and manufactures fuel injection equipment, automatic mixture controls, and related equipment for aircraft applications. Prior to joining Eclipse Mr. Deschamps was an engineer with the Bristol Aeroplane Co., Ltd., Bristol, England.

RICHARD O. McMANUS is now in training to become an engineering officer in the Army Air Forces, Air Corps Technical School, Chanute Field, Ill. He had been junior test engineer at the Eclipse Aviation Division, Bendix Aviation Corp., Bendix, N. J.

JOHN WALKER, who had been manager of sales engineering, was promoted to the position of assistant to the chief engineer, and was transferred from the Long Island City office of the Mack Mfg. Corp. to their Allentown headquarters.

HARRY HALL was recently appointed assistant chief engineer from the position of development and research engineer, the Worthington Pump & Machinery Corp.

J. M. WATSON has joined the metallurgical staff of the McCord Radiator & Mfg. Co., Detroit.

Formerly employed in the engineering department of the Waukesha Motor Co. as design engineer, **ELLSWORTH D. WILKIN** has left that company to take an engineering position with the Jacobsen Mfg. Co. of Racine, Wis.

FRANK R. WEST, who had been with the Excel Foundry & Machine Co., Inc., New York City, as vice president of engineering, now holds a similar position with the Precision Mfg. Corp., Fall River, Mass.

General Motors Overseas Operations has assigned **OSCAR C. THOMAS** to duty in Great Britain as a technical civilian. Mr. Thomas has been diesel service engineer for General Motors Overseas Operations, Detroit.

ARTHUR C. BLOOMER is now employed by Continental Motors Corp., at Garland, Tex., as junior engineer in the produc-

tion department. Mr. Bloomer was formerly with the Buda Co., Harvey, Ill., as junior draftsman.

On leave of absence from Sperry Products, Inc., Hoboken, N. J., **G. LESTER JONES** is works manager for the War Products Division of Eversharp, Inc., Chicago, where they are engaged in the manufacture of aviation instruments and controls.

Formerly chief engineer at J. Stuart McLerie, Ltd., Windsor, Ont., Canada, **WALTER G. CHANDLER** has been made engineer of specifications machine tools, Chrysler Corp.'s Plant No. 3, Windsor.

L. G. KURTZ, director of motor equipment, has been transferred from the New York City Department of Sanitation to the New York City Department of Public Works. Mr. Kurtz is Transportation & Maintenance Activity vice chairman of the Metropolitan Section.

The following SAE student members are engaged in essential war work: **JOHN L. SENIOR, JR.,** Massachusetts Institute of Technology, now junior aerodynamicist at the Glenn L. Martin Co., Middle River, Md.; **WILLIAM K. KOFFEL,** University of Michigan, junior mechanical engineer with the National Advisory Committee for Aeronautics, Cleveland; **JACK D. McNAMER,** Chrysler Institute of Engineering, now mechanical engineer with the Chrysler Corp.'s Engineering Division, Highland Park, Mich.; **V. J. GRUMBLATT,** Michigan State College, now methods engineer with the Sperry Gyroscope Co., Brooklyn, N. Y.; **ARTHUR F. BASKE,** Michigan State College, now on the engineering staff of General Motors Corp., Detroit; **JOSEPH E. GRAY,** University of Detroit, now dynamometer technician at the Lincoln Division of the Ford Motor Co., Detroit.

E. H. DIX, JR., chief metallurgist of the Aluminum Research Laboratories, Aluminum Co. of America, was named an assistant director of the company. Mr. Dix has been with this company since 1923, and was appointed chief metallurgist in 1930.

E. H. Dix

Obituaries

Charles W. Fletcher

Charles W. Fletcher, president of the Titeflex Metal Hose Co., Newark, N. J., died recently at the age of 68. In 1914 Mr. Fletcher organized the Titeflex Metal Hose Co., of which he has since remained its president. Before organizing this company, he had been successively with the General Electric Co. in the electrical engineering department, the Morse Chain Co., and Walter Motor Truck Co. as chief engineer. A member of the SAE since 1911, Mr. Fletcher received a B.S. degree from the University of Kansas.

James H. Connolly, Jr.

James H. Connolly, treasurer and general manager of the Standard Machinery Co., Providence, died recently at the age of 59. Mr. Connolly received a Sc. B. degree in electrical engineering from Brown University in 1905.

In Military Services

CAPT. LAWRENCE J. GRUNDER returned to the United States recently from an assignment in the Eastern Theatre of Operations Command, United Kingdom, to which he had been attached for several months. He had been studying lubrication and fuels requirements of our armed forces, and is now en route to another war theatre in a technical capacity. He visited SAE Headquarters office in New York while in the United States. Capt. Grunder was formerly automotive engineer of the Richfield Oil Corp., is a former member of the Council of the Society and a past chairman of the SAE Southern California Section.

P. J. PICCIRILLI, formerly consulting engineer, U. S. Industrial Alcohol Co., New York City, has been commissioned lieutenant commander in the U. S. Navy.

JAMES D. MOONEY has been promoted from lieutenant commander to commander, USNR. He is head of the Manufacturing Operations Section, Production Branch, Bureau of Aeronautics, Navy Department, Washington.

Formerly supervisor of automotive transportation, Tide Water Associated Oil Co., New York City, **T. L. PREBLE** is now a colonel in the Ordnance Department, U. S. Army, and is headquartered in Washington.

COL. H. R. HARRIS, who had been vice president of Pan American-Grace Airways, Inc., New York City, is in the U. S. Army Air Forces, Annex No. 1, Gravelly Point, Va.

LT.-COM. W. L. ANDERSON, formerly with the U. S. S. Thresher, is now in the Industrial Department of the Mare Island Navy Yard, Calif.

CAPT. J. M. CAWOOD, who had been supervisor of the Safety Inspection Division, Department of Vehicles and Traffic, Washington, is now in the Ordnance Department of the U. S. Army.

CAPT. STANLEY J. CZYZAK is on foreign duty with the U. S. Army Air Forces. He was formerly a first lieutenant, U. S. Army Air Forces, Fairfield, Ohio.

CLYDE A. DIVELY is a lieutenant in the War Department, Pittsburgh District Ordnance Office. Lt. Dively was formerly an engineer in the Research Department

of the International Harvester Co., Inc., Fort Wayne, Ind.

Formerly vibration engineer, Curtiss-Wright Corp., Propeller Division, Caldwell, N. J., **LT. MILLARD FILLMORE PERRY** is now in the U. S. Army Air Forces. He is project engineer officer at the experimental Engineering Section, Materiel Center, Wright Field, Dayton, Ohio.

LT. HAROLD W. CLOUD, formerly in field artillery, and stationed at Indianapolis, has been transferred to Headquarters 85th Infantry Division, U. S. Army, Camp Shelby, Miss.

W. H. BOSHOFF, Ordnance Department of the U. S. Army, was commissioned from master sergeant to captain several months ago, and sent to Camp Blanding, Fla., where he has been functioning as District Motor Maintenance Officer.

CAPT. A. D. SMITH is in the Quartermaster Motor Transport Division of the U. S. Army, and is stationed at Goldsborough Field, N. C. Prior to joining the Army Capt. Smith was motor truck salesman, the International Harvester Co., Oklahoma City, Okla.

JOHN D. ZERBO, who had been traffic and service manager, Streitmann Biscuit Co., Cincinnati, is a captain in the U. S. Army, Specialist Corps, Rock Island Arsenal, Ill. He is in Field Service, Transportation Section.

CAPT. GEORGE DOOLE has been transferred from Avianca-Pan American Airways, Barranquilla, Colombia, S. A., to Pan American Airways, La Guardia Field, New York.

LT. WALLACE BRENNAN, formerly in the U. S. Army Quartermaster Motor Transport School Staff, Port of Stockton, Calif., has been transferred to Headquarters Company, 1st Battalion, 125th Ordnance Motor Base Regiment, and can be reached through A.P.O. No. 1224, New York City.

ROBERT N. DOBBINS has been given a leave of absence from his position of supervisor of War Production Training with the Essex County Vocational Schools for the duration. He has accepted a commission in the U. S. Navy as lieutenant with orders to active flight duty at the U. S. Naval Air Station, Pensacola, Fla.

GRAY FARR, mechanical engineer, has been commissioned a lieutenant (JG) in the United States Naval Reserves.

LT. PAUL L. HAINES has been transferred from the 443rd Aviation Ordnance Company, Blythe, Calif., to the Ordnance Tank Engineering Office, Detroit.

FRED J. GRUMME has enlisted in the U. S. Navy as an aviation cadet. Mr. Grumme was civilian automotive instructor, War Department, Camp Lee, Va.

W. S. COOPER, who had been principal mechanical engineer, U. S. War Department, Office of the Quartermaster General, Washington, is now principal materials engineer in the Conservation Division, Specifications Branch, War Production Board, Washington.

TECHNICAL SGT. WILLIAM J. RICE, formerly with the Lincoln and Lincoln Zephyr Department, Sol. Schildkraut, Inc., Jamaica, L. I., N. Y., is in a coast artillery anti-aircraft regiment, at Fort Totten, N. Y. His duty is taking care of battery trucks and jeeps.

JOSEPH DEKTOR has enlisted in the U. S. Army Air Forces as an aviation cadet. Although not called for training yet, Mr. Dektor has left his position with the Pratt & Whitney Aircraft Division, United Aircraft Corp., East Hartford, Conn., where he was assistant engine tester.

MAJOR AL BODIE, production expediter, U. S. Army Air Forces, has recently been assigned to the Western Procurement District. His headquarters are at Santa Monica, Calif.

MAJOR F. M. PAULL, formerly chief automotive adviser, U. S. Army, Quartermaster Corps, 2nd Corps Area, Governors Island, N. Y., has transferred to Southern District Shops, Fort Dix, N. J. He is District Motor Transport Officer in the Ordnance Department.

CAPT. HORACE R. HIGGINS is now chief of the Visit Report Unit, Coordinating Section, Executive Branch, Field Service Division, U. S. Army, Ordnance Department, Arlington, Va. He had been in the Office of the Quartermaster General, Motor Transport Service, Washington.

GROUP CAPT. FRANCIS R. BANKS is director of Engine Production, Ministry of Aeroplane Production, of the British Government. For more than 10 years a member of the SAE, he was technical manager and chief engineer of the Associated Ethyl

Capt. Francis R. Banks

Co., Ltd., London, and has been a frequent speaker before the SAE and technical groups in this country and abroad. He was recently honored with the award of Order of the British Empire, and is a member of the RAF Volunteer Reserves.

CAPT. JOHN G. MAC'KIE, Infantry Commander, is with the 1st Parachute Training Regiment under the Airborne Command. Before entering military service, Capt. Mac'kie was executive assistant to the director, Civilian Conservation Corps, Washington.

CAPT. JOHN ST. HORNOW formerly with the U. S. Army, 422nd Engineers Company, has been switched to the 436 Engineers Company. Capt. St. Hornow is stationed at Camp Claiborne, La.

For several months **CAPT. WALLACE H. DAVIS** has been on active duty with the Quartermaster Corps, U. S. Army, and is now stationed at Selfridge Field, Mich. Capt. Davis was formerly superintendent of garage, Village of Winnetka, Winnetka, Ill.

Formerly experimental engineer, the Mawen Motor Corp., New York City, **JOHN I. CICALA** is a lieutenant in the U. S. Army, Ordnance Department, Tank and Automotive Center, Maintenance Branch, Technical Section, Tank Unit, Detroit.

LT. EARLE G. FAHRNEY has been on active duty for several months with the Ordnance Division of the U. S. Army, with headquarters in Detroit. In civilian life Lt. Fahrney was test engineer in the Transmission Division of General Motors, Detroit.

CAPT. W. A. BROWN, Quartermaster Corps, is in service in Australia. Previously Capt. Brown was senior instructor at the Quartermaster Motor Transport School, Stockton, Calif.

LT. JOHN R. HOWARD, III, formerly in the U. S. Army Ordnance Department, Ordnance Training Center, Aberdeen, Md., has been transferred to the General Motors Truck & Coach Division of Yellow Truck & Coach Mfg. Co., Pontiac, Mich., where he is Army inspector of ordnance.

LT. ROYCE CHILDS, U. S. Army, Maintenance Battalion, 2nd Armored Division, has been transferred from Fort Benning, Ga., to Fort Bragg, N. C.

LT. LOUIS G. BURNS is in the Experimental Engineering Section, U. S. Army Air Forces, Materiel Center, Wright Field, Dayton, Ohio. Prior to duty in the U. S. Army, Lt. Burns was project engineer at the Pump Engineering Service Corp., Division of the Borg-Warner Corp., Cleveland.

Formerly editor of *Petroleum Marketer*, Shaw Publishing Co., Chicago, **LT. BRANDON E. ROURKE,** USNR, is now on active duty with the U. S. Navy.

LT. G. G. EMERSON, USNR, is at the Post Graduate School, U. S. Naval Academy, Annapolis, Md. He had been connected with the Curtiss-Wright Corp. in Washington.

NEW MEMBERS Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between Sept. 15, 1942, and Oct. 15, 1942.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section

Stone A. Rivington (J) development engineer, , Geroter May Division, May Oil Burner Corp., Maryland Ave. & Oliver St., Baltimore (mail) Anneslie, 705 Dunkirk Rd.

Buffalo Section

Alevizon, George V. (J) draftsman, Bell Aircraft Corp., Buffalo (mail) 132 College St.

Askin, Joseph (M) chief engineer, Fedders Mfg. Co., Inc., Buffalo (mail) 57 Tonawanda St.

Goffin, Robert Thomas (M) process engineer, Sterling Engine Co., 1270 Niagara St., Buffalo (mail) 584 Minnesota Ave.

Redford, Everett R. (M) production manager, Sterling Engine Co., Buffalo (mail) 1141 Delaware Ave.

Canadian Section

Halip, Nickolas Joseph (J) body engineer, Ford Motor Co. of Canada, Ltd., Windsor, Ont. (mail) 1380 Benjamin Ave.

Riley, Ronald T. (A) secretary, treasurer, Canadian Pratt & Whitney Aircraft Co., Ltd., Longueuil, Que.

Chicago Section

Boardman, Herbert L. (A) tool and machine designer, Foote Bros. Gear & Machine Corp., 4545 S. Western Blvd., Chicago (mail) 1614 Diversey Pkwy.

Cox, Robert J. (J) layout draftsman, Bendix Products Division, Bendix Aviation Corp., 401 Bendix Dr., South Bend, Ind. (mail) 1109 W. Oak.

Damron, Houston A. (J) assistant mechanical engineer, inspection section, U. S. Army Air Forces, Materiel Center, Wright Field, Dayton, Ohio (mail) 1326 S. 17th St., Maywood, Ill.

Daniels, Ted E. (J) liaison engineer, Bendix Products Division, Bendix Aviation Corp., 401 Bendix Dr., South Bend, Ind.

Greer, John W. (J) designer, Electro-Motive Division, General Motors Corp., LaGrange, Ill. (mail) 12302 S. 71st Ave., Palos Heights, Ill.

Lenguadoro, Joseph A. (A) auto mechanic, Public Service Co. of Northern Illinois, Chicago (mail) 5310 Pensacola Ave.

Traise, Earle F. (A) industrial and equipment sales, Wilkening Mfg. Co., 2000 S. 71st St., Philadelphia (mail) 2619 S. Michigan Ave., Chicago.

Cleveland Section

Buechling, W. J. (M) chief metallurgist, Copperweld Steel Co., Mahoning Ave. Ext., Warren, Ohio.

Heller, Joseph R. (A) vice president, general manager, Elco Grease & Oil Co., Jennings Rd. & Denison Ave., Cleveland.

Honroth, Kenneth A. (J) project engineer, Jack & Heintz, Inc., Bedford, Ohio.

Zimmerman, H. A. (J) engineer, Weatherhead Co., 300 E. 131st St., Cleveland.

Detroit Section

Bogan, Bernard W. (M) engineer, Chrysler Corp., Highland Park Engrg., Detroit (mail) 232 Baldwin, Birmingham, Mich.

Borden, David M. (M) engineer, Chrysler Corp., Detroit (mail) 906 Forestdale Rd., Royal Oak, Mich.

Dedrick, John H., Jr. (J) metallurgical engineer, S. K. Wellman Co., 210 Curtis Bldg., Detroit.

Garrett, L. W. (M) development engineer, Continental Motors Corp., 12801 E. Jefferson, Detroit (mail) 4830 Guilford.

Grogan, Richard F. (J) draftsman, Pontiac Motor Division, General Motors Corp., Pontiac, Mich. (mail) 241 Franklin Rd.

Homent, Joseph (A) assistant foreman, tool department, Federal Engrg. Co., 850 Oakman Blvd., Detroit (mail) 8094 Smart.

Johnson, Miles E. (M) assistant engineer, Continental Aircraft & Engrg. Co., Detroit (mail) 4368 Nottingham Rd.

Kotowski, Bruno (J) production supervisor, Murray Corp. of America, Detroit (mail) 2048 Belmont St., Hamtramck, Mich.

Mather, Roger Frederick (J) consulting metallurgist, Willys-Overland Motors, Inc., P. O. Box 903, Toledo, Ohio.

McCarthy, George Daniel (J) research engineer, Chrysler Corp., Engineering Division, 12800 Oakland Ave., Highland Park, Mich. (mail) 235 Cortland, Apt. 104.

Miller, Glen A. (A) president, general manager, Superior Metal Products Co., Auburn Heights, Mich.

Schulte, Gerard J. (M) sales engineer, Mohun & Leininger, 406 Fisher Building, Detroit.

Indiana Section

Hicks, Earl M. (M) president, Hicks Body Co., Inc., 510 Indianapolis Ave., Lebanon (mail) 604 W. North St.

Roemer, Arthur James (J) layout draftsman, Allison Division, General Motors Corp., Indianapolis (mail) 3847 Graceland Ave.

Kansas City Section

Hudson, Finn S. (M) chief engineer, Keystone Trailer Co., 1501 Guinotte Ave., Kansas City, Mo.

Metropolitan Section

Arbuckle, Philip Harlow (J) process engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 53 Parkway E., Bloomfield, N. J.

Bandzevich, John F. (J) senior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) P. O. Box 71, Great Notch, N. J.

Barker, Robert White (A) senior research man, Adams Express Co., 40 Wall St., New York City.

Braumuller, George C. (A) purchasing agent, Breeze Corporations, Inc., 41 S. Sixth St., Newark, N. J. (mail) 811 Ridge St.

Budds, H. H. (M) vice president, general manager, Ranger Aircraft Engines, Division of Fairchild Engine & Airplane Corp., Farmingdale, L. I., N. Y. (mail) 38 Kensington Rd., Garden City, L. I., N. Y.

Daum, George A. (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 13 Hanford Pl., Caldwell, N. J.

Detra, Irvin G. (J) experimental test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) R.F.D. No. 1, Midland Park, N. J.

Esterline, Herman L. (A) automotive engineer, The Texas Co., 135 E. 42nd St., New York City.

Fleuriot, Robert George (J) liaison engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) Brinckerhoff Manor, E. Palisade Ave., Englewood, N. J.

Freeman, Philip B. (J) test engineer, Ranger Aircraft Engines, Division of Fairchild Engine & Airplane Corp., Farmingdale, L. I., N. Y. (mail) 712 Fulton St.

Gatto, Attilio Arthur (A) field service engineer, Electro Products Co., 621 E. 216th St., New York City (mail) 95-11 40th Rd., Elmhurst, L. I., N. Y.

Grange, Robert Douglass (J) senior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 223 Bellevue Ave., Upper Montclair, N. J.

Hackney, Clarence W. (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Plant No. 1, Paterson, N. J. (mail) 456 Van Houten St.

Hafemeyer, Alfred J. (A) territory representative, Bear Mfg. Co., Rock Island, Ill. (mail) 8829 81st Rd., Glendale, L. I., N. Y.

Heikin, Jacob (J) administrative procurement inspector, U. S. Army Air Forces,

Materiel Division, Inspection Section, Wright Aeronautical Corp., Paterson, N. J. (mail) 194 E. 31st St.

Irons, Harvey C. (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 5 Fairfield St., Upper Montclair, N. J.

James, Robert Louis (J) test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 51 Elston Rd., Montclair, N. J.

Kibbe, Ike (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 738 E. 22nd St.

Kirk, Howard Franklin, Jr. (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 23 Berwyn St., East Orange, N. J.

Kreidler, Frank G. (J) field engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 325 Plaza Rd., Fairlawn, N. J.

Kunna, Frank John (M) chief field service engineer, Eclipse Aviation, Division of Bendix Aviation Corp., Bendix, N. J. (mail) 295 Edgewood Ave., West Englewood, N. J.

Larger, Joseph George (A) detail draftsman, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 145 Mahar Ave., Clifton, N. J.

McArdle, Charles J. (A) assistant director, transportation, General Baking Co., 420 Lexington Ave., New York City (mail) 88-27 145th St., Jamaica, L. I., N. Y.

Mellenger, Edmund Rex (M) Ward & Palzer, 149 Broadway, New York City.

Mercy, Kenneth R. (S M) associate mechanical engineer, U. S. Navy, Navy Yard, Brooklyn, N. Y. (mail) 77-07 138th St., Kew Garden Hills, L. I., N. Y.

Mills, Malcolm E. (M) assistant standards engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 247 E. Fourth St., Clifton, N. J.

Moyer, Charles R. (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 23 Maple Pl., Clifton, N. J.

Pitts, Charles N. (J) test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 523 14th Ave.

Reed, George M. (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) F3, Abbott Court, Radburn, N. J.

Reid, William Charles (M) vice president, charge field engineering and sales, Metallizing Engrg. Co., Inc., 21-07 41st Ave., Long Island City, N. Y.

Rentzel, Delos W. (A) superintendent of communications, American Airlines, Inc., Municipal Airport, Jackson Heights, L. I., N. Y.

Richter, Joseph (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 519 E. 23rd St.

Schwartz, Edward W. (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 25 Manor Ave., Box 448, Pompton Plains, N. J.

Simonds, Arthur P. (J) senior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) Box 86, Little Falls, N. J.

Sweeney, Charles H. (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 365 12th Ave., Apt. C9.

Taylor, Myron L. (M) engineer, Eclipse Aviation, Division of Bendix Aviation Corp., Bendix, N. J. (mail) 301 Hamilton Rd., Ridgewood, N. J.

Thompson, John B. (J) junior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) 66 Pennsylvania Ave.

Troy, Leonard (J) engineer, charge weights and structures, Aeronautical Division, Snead & Co., Orange, Va. (mail) 2359 E. 18th St., Brooklyn, N. Y.

Wells, E. Frederick (J) senior test engineer, Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Paterson, N. J. (mail) Garside Ave., Preakness, R. D. 3.

Wilkins, Dale Emmet (J) senior test engineer, Wright Aeronautical Corp., Division

of Curtiss-Wright Corp., Paterson, N. J. (mail) 4 Brighton Pl., Radburn, N. J.

Wuerz, Oscar W. (M) experimental engineer, Cab Service & Parts Corp., 315 W. 68th St., New York City (mail) 8801 Shore Rd., Brooklyn, N. Y.

Milwaukee Section

Cox, Earle Floyd (J) drafting, Allis-Chalmers Mfg. Co., West Allis, Wis. (mail) 6663 W. Chambers St., Milwaukee.

McMillan, Andrew (M) designing engineer, Chain Belt Co., 1600 W. Bruce St., Milwaukee.

Petersen, Esbern A. (M) assistant chief engineer, tractor division, Massey-Harris Co., Racine, Wis.

New England Section

Ottmar, Jerome (J) engineering and sales department, Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.

Rice, J. Herbert (A) general manager, Roger Williams Oil Co., 143 Alger Ave., Providence, R. I. (mail) 446 Park Ave., Cranston, R. I.

Northern California Section

Hundley, Roy A. (M) chief engineer, Enterprise Engine & Foundry Co., 600 Florida St., San Francisco (mail) 2712 36th Ave.

Weiss, Virgil E. (A) automotive engineer, Standard Oil Co. of Calif., Room 1632, 225 Bush St., San Francisco.

Northwest Section

Kanehl, Hugh P. (M) fleet superintendent, Inland Motor Freight, S. 110 Sheridan St., Spokane, Wash. (mail) 1527 E. 18th Ave.

Olds, Robert H. (J) power plant engineer, Boeing Aircraft Co., Seattle, Wash. (mail) 1863 Hamlin St.

Philadelphia Section

Roach, J. Donald (M) sales engineer, U. S. Asbestos Division, Raybestos-Manhattan, Inc., Manheim, Pa. (mail) Silver Springs, Columbia, R. D. 1, Lancaster Co., Pa.

Pittsburgh Section

Gill, Leo Albert (A) automobile mechanic, Municipal Garage & Repair Shop, Pittsburgh (mail) 3209 Brereton Ave.

St. Louis Section

Marien, Melvin W. (M) assistant chief engineer, Ramsey Accessories Mfg. Corp., 3693 Forest Park Blvd., St. Louis (mail) 8610 Rosalie, Brentwood, Mo.

Southern California Section

Alexander, Issac E. (M) machine and tool designer, North American Aviation, Inc., Inglewood, Calif. (mail) 127 W. Beach St.

Anger, Rudolph (A) teacher (aircraft), George Washington High School, Los Angeles (mail) 6026 Ladera Park Ave.

Chandler, Kenneth (A) owner, Ken Chandler Auto Repair, 4314 W. Adams Blvd., Los Angeles.

Corley, Joseph Warren (M) instructor, Board of Education, City of Los Angeles, 1151 S. Broadway, Los Angeles (mail) 1721 Westmoreland Blvd.

Johnson, Walter M. (A) superintendent, fleet maintenance, metal construction, Hal Roach Studios, Culver City, Calif. (mail) 10473 Troon Ave., Los Angeles.

Smalley, Francis Willard (A) used truck foreman, International Harvester Co., 4501 S. Alameda, Los Angeles (mail) 3326 Dorchester Ave.

Stinson, Edgar Douglas, Jr. (A) 4859 W. 12th St., Los Angeles.

Southern New England Section

Coar, Richard J. (J) experimental test engineer, Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn. (mail) 60 N. Main St., West Hartford, Conn.

Gamage, Russell Wells (J) salvage engineer, Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn. (mail) Apt. 34, 23 Chapman St.

Ketcham, Bruce Valentine (J) designer, Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn. (mail) 105 S. Main St., West Hartford, Conn.

Robidoux, Conrad (A) inspector salvage, Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn. (mail) 214 Elmfield St., West Hartford, Conn.

Texas Section

Adams, Clyde E. (A) general manager, Guiberson Corp., Aircraft & Heater Division, P. O. Box 1106, Dallas (mail) 2239 Lawndale Ave.

Barlow, Howard Walter (M) professor, head, department of aeronautical engineering, Agricultural & Mechanical College of Texas, College Station (mail) Box F. E. 4.

Marsh, Holdridge Waldron (M) senior tool designer, Consolidated Aircraft Corp., Plant No. 3, Fort Worth (mail) Route 2, Box 427.

McKinney, H. H. (J) Continental Motors Corp., Texas Division, Dallas (mail) P. O. Box 152, Richardson.

Thompson, M. J. (M) professor, aeronautical engineering, University of Texas, Department of Aeronautical Engineering, Austin.

Truettner, W. I. (M) associate professor, mechanical engineering, Agricultural & Mechanical College of Texas, College Station.

Washington Section

Houston, George F. (S M) engineer, Navy Department, Bureau of Ships, Diesel Engine Section, Washington (mail) 2709 Central Ave., Alexandria, Va.

Olsen, John T., Lt. (jg) (S M) Navy Department, Bureau of Aeronautics, Washington (mail) 4528 Fessenden St., N. W.

Outside of Section Territory

Broderick, John J. (M) engine designer, Caterpillar Military Engine Co., Victory Ordnance Plant, Decatur, Ill. (mail) 340 W. Center St.

Burks, George Edwin (M) chief engineer, Caterpillar Tractor Co., Peoria, Ill. (mail) 1602 Bigelow St.

Burnett, Edward Lee (J) permanent mold engineer, Dow Foundry Division, Dow Chemical Co., Patterson Ave., Bay City, Mich. (mail) 401 N. Henry St.

Davis, Harry Francis (A) field engineer, Cords Piston Ring Co. of Canada Ltd., 834 Johnson St., Victoria, B. C., Canada (mail) 1126 Oxford St.

Hunt, C. Kenneth (A) sales and service engineer, Automotive Supply Co., Inc., 62 Central Ave., Albany, N. Y. (mail) 4 Alden Court, Delmar, N. Y.

Klompas, Wm. M. (J) engine overhaul, McKenzie Air Service, Edmonton, Alta., Canada (mail) 31, E.F.T.S., De Winton Alta., Can.

Morris, Harold H. (A) lubricating engineer, United Petroleum Corp., Omaha, Nebr. (mail) 1010 Sheridan Blvd., Denver, Colo.

Riple, James C., Jr. (J) junior test engineer, The Aviation Corp., Lycoming Division, Williamsport, Pa. (mail) Apt. 9, 406 High St.

Vivian, Frank H. (M) sales engineer, Four Wheel Drive Auto Co., 12th St., Clintonville, Wis. (mail) 158 Motor St.

Youngblutt, Sumner Paul (J) engineering cadet, U. S. Army Air Forces, Newell, S. D.

Foreign

Cole, Richard Barnes (F M) director, Standard Motor Co., Ltd., Coventry, England (mail) 2 The Warren, Lillington Rd., Leamington Spa.

Government of the Commonwealth of Australia, Division of Aeronautics, Council for Scientific & Industrial Research (Depart'l) Lorimer St., Fishermen's Bend, S. C. 8, Victoria, Australia. Rep: Coombes, L. C., chief, division of aeronautics.

Snowball, John Thomas (F M) production engineer, E. R. F. Ltd., Sun Works, Sandbach, Cheshire, England.

APPLICATIONS Received

The applications for membership received between Sept. 15, 1942, and Oct. 15, 1942, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Baltimore Section

Carlson, **John W.,** Lt., U. S. Army, Ordnance Department, Holabird Ordnance Motor Base, Md.

Easton, Archie H., assistant engineer, U. S. Army, Ordnance Department, Automotive Test & Research Division, Aberdeen Proving Ground, Md.

Gross, William A., Jr., automotive engineer, U. S. Army, Ordnance Department, Automotive Test & Research Division, Aberdeen Proving Ground, Md.

Hitch, Robert Arthur, power plant development, Glenn L. Martin Co., Baltimore.

Canadian Section

Beveridge, George Leslie, chief engineer, Laurentian Air Services, Ltd., Ottawa, Ont.

Brooks, Kenneth F., works manager, National Steel Car Corp., Ltd., Malton, Ont.

Renwick, Richard John, assistant head, automotive engineering department, Ford Motor Co. of Canada, Ltd., Windsor, Ont.

Simpson, Ernest Leslie, department head, Ford Motor Co. of Canada, Windsor, Ont.

Skinner, Harold Fred, draftsman, General Motors Products of Canada, Ltd., Oshawa, Ont.

Chicago Section

Apex Smelting Co., Chicago.

Bezek, Albert J., engineer, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

Bogue, Leonard E., design engineer, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

Borden, Donald A., project engineer, Bendix Aviation Corp., South Bend, Ind.

Bowles, Hugh G., junior engineer, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

Chisholm, James M., project engineer, Bendix Aviation Corp., South Bend, Ind.

Christiansen, Edward S., vice president, Apex Smelting Co., Chicago.

Davis, Richard A., assistant engineering laboratory supervisor, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

Gill, Joseph H., project engineer, Bendix Aviation Corp., South Bend, Ind.

Hokenson, Howard Glenn, assistant installation engineer, Electro-Motive Division, General Motors Corp., LaGrange, Ill.

Hossfeld, Fred E., automotive engineer, Ivano, Inc., Chicago.

Johnson, Rossall J., project engineer, Bendix Aviation Corp., South Bend, Ind.

Kelsey, William E., production engineer, Bendix Aviation Corp., South Bend, Ind.

Kingman, David T., production research engineer, Bendix Aviation Corp., South Bend, Ind.

May, Don, Jr., project engineer, Bendix Aviation Corp., South Bend, Ind.

Miller, Dorr William, project engineer, Bendix Aviation Corp., South Bend, Ind.

Nicholson, Melvin R., experimental engineer, The Buda Co., Harvey, Ill.

Pence, Harry Henry, principal automotive adviser, U. S. Army, Plans & Training Branch, Automotive Section G-4, Chicago.

Peterson, Robert H., project engineer, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

Ruge, Irwin W., 2nd Lt., U. S. Army, Robins Field, Wellston Air Depot, Ga. Mail: 139 Country Club Road, Chicago Heights, Ill.

Schnaible, Albert P., research engineer, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

Wilson, Harold Clifford, aircraft engineer, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

Wilson, Wesley, president and chief engineer, Wilson Mfg. Corp., Chicago.

Cleveland Section

Abramoska, Paul, president and general manager, Paul Abramoska & Co., Parma, Ohio.

Brauer, Walter J., assistant manager sales orders and service department, Weatherhead Co., Cleveland.

Bonsack, Walter, chief metallurgist, National Smelting Co., Cleveland.

Cableck, Edward L., chief chemist, Weatherhead Co., Cleveland.

Canfield, W. E., division manager, The S. K. Wellman Co., Cleveland.

Craig, Charles T., director of purchases and assistant secretary, Weatherhead Co., Cleveland.

Elicker, Leonard N., manager, Advance Plating Co., Cleveland.

Fields, George C., assistant chief engineer, Apex Electrical Mfg. Co., Cleveland.

Gilchrist, David, Jr., personnel director, Weatherhead Co., Cleveland.

Griffith, Donald L., sales manager, National Malleable & Steel Castings Co., Cleveland.

Hering, Charles Edward, dynamometer engineer, White Motor Co., Cleveland.

Herold, Robert Edward, mechanical engineer, Weatherhead Co., Cleveland.

Howard, Wayne R., test engineer, White Motor Co., Cleveland.

Kelly, John N., owner-manager, Kelly Plating Co., Cleveland.

Kemble, Edward D., factory manager, Cleveland Automatic Machine Co., Cleveland.

McClain, William S., methods engineer, Thompson Products, Inc., Cleveland.

Newmier, Carleton H., engineering draftsman, Thompson Products, Inc., Cleveland.

Noon, T. Cyril, engineer, Thompson Products, Inc., Cleveland.

Oberst, Harry E., draftsman, Pump Engineering & Service Corp., Cleveland.

Orr, Charles Frederick, Jr., development department, Mansfield Tire & Rubber Co., Mansfield, Ohio.

Phillips, A. W., general superintendent, tire and truck division, B. F. Goodrich Co., Akron, Ohio.

Phillips, Robert W., engineer, Weatherhead Co., Cleveland.

Prijatel, Edward A., draftsman, Pump Engineering & Service Corp., Cleveland.

Remley, Roland E., Jr., liaison representative with Army Air Forces, Dayton. Mail: Weatherhead Co., Cleveland.

Sanders, Howard W., sales, Weatherhead Co., Cleveland.

Snyder, J. Rush, engineer, Thompson Products, Inc., Cleveland.

Spaulding, Howard G., designer, White Motor Co., Cleveland.

Vander Veer, Willard, chief test operator, Thompson Products, Inc., Euclid, Ohio.

Waag, Norman Earl, engineer, Thompson Products, Inc., Cleveland.

Dayton Section

Blue, Claybourne, Capt., U. S. Army Air Corps, Chief, Unit No. 2, Shipping & Storage Group, Dayton.

Coote, Charles W. M., estimating engineer, Davis Welding & Mfg. Co., Cincinnati, Ohio.

Martin, Thomas B., project engineer, Aeroproducts Division, General Motors Corp., Dayton.

Detroit Section

Braik, Ralph A., service engineer, Detroit Diesel Engine Division, General Motors Corp., Detroit.

Ernat, Anthony M., project mechanic, Research Laboratories Division, General Motors Corp., Detroit.

Evans, Eldred E., chief inspector, Wayne Division, Bendix Aviation Corp., Wayne, Mich.

Ford, James Ira, engineer contractor, F. L. Jacobs Co., Detroit.

Goetsch, Earl George, junior machine tool engineer, Process Gear & Machine Co., Detroit.

Gorman, John J., vice president, E. A. Laboratories, Detroit.

Gossom, Charles Othell, chief draftsman, Chevrolet Gear & Axle Division, General Motors Corp., Detroit.

Hall, Clarence A., research engineer, Ethyl Corp., Detroit.

Higbie, Alan Lighthall, research engineer, Chrysler Corp., Highland Park, Mich.

Keller, Sam T., owner, Sam T. Keller, 7310 Woodward Ave., Detroit.

Knell, Robert William, Jr., U. S. Army Air Force. Mail: 663 Lincoln Road, Grosse Pointe, Mich.

Moeller, Everett George, junior project engineer, Chrysler Corp., Highland Park, Mich.

Newton, John Donald, II, junior tool designer, Hudson Motor Car Co., Detroit.

Noftz, Mearl E., junior engineer, Chrysler Corp., Highland Park, Mich.

Page, Gordon Clarke, aeronautical engineer, Continental Motors Corp., Detroit.

Peckham, E. Gail, engineer, Buick Motor Division, General Motors Corp., Detroit.

Pratt, Albert S., Jr., engineer, Skinner Purifiers, Inc., Detroit.

Rothmeyer, Joseph W., consulting engineer, 913 Fisher Bldg., Detroit.

Rothwell, Philip M., project engineer, Chrysler Corp., Highland Park, Mich.

Ruettinger, Thurman O., structures engineer, Chrysler Corp., Highland Park, Mich.

Smith, Philip H., engineer, Thompson Products, Inc., Detroit.

Smothers, William C., experimental test engineer, Continental Motors Corp., Detroit.

Stern, Abraham I., assistant engineer, U. S. Army Air Forces, Central Procurement District, Materiel Division, Detroit.

Switzer, McDonald, assistant sales manager, Federal-Mogul Service, division of Federal-Mogul Corp., Detroit.

Twyman, L. Raymond, manager, industrial division, sales and application engineering department, Vickers, Inc., Detroit.

vanDerZee, Abram, vice president, Chrysler Corp., Detroit.

Wrinn, Gordon W., vice president and general manager, Claude Sintz, Inc., Detroit.

Kansas City Section

Allbritain, Richard Lee, chief chemist, Great Lakes Pipe Line Co., Kansas City.

Indiana Section

Turner, Roscoe, Col., president, Roscoe Turner Aeronautical Corp., Municipal Airport, Indianapolis.

Metropolitan Section

Anderson, Franklin T., executive engineer, Titeflex Metal Hose Co., Newark, N. J.

Atwood, Henry M., field engineer, Metallizing Co. of America, New York City.

Bower, William S., senior test engineer, experimental department, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Cobb, Edward Sprague, test engineer, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Brubaker, Norman Harold, research engineer, Standard Oil Development Co., Elizabeth, N. J.

Cole, Rossa W., test engineer, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Cummings, Roy, chief inspection methods engineer, Propeller Division, Curtiss-Wright Corp., Caldwell, N. J.

Erdman, Frank H., junior engineer, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Ferenczi, Louis M., research engineer, Standard Oil Development Co., Elizabeth, N. J.

Farrah, Jere Tiffin, analyst, American Airlines, Inc., Municipal Airport, Jackson Heights, N. Y.

Farrell, Matthew H., tool and equipment inspector, U. S. Army, Hampton Roads Port of Embarkation, Army Base, Norfolk, Va. Mail: c/o Capt. Guy D. Davis, 451 Fire Island Ave., Babylon, N. Y.

Fowler, E. Washburne, automotive consultant, technical analyst, Board of Economic Warfare, New York City.

Hardy, Edwin A., junior test engineer,

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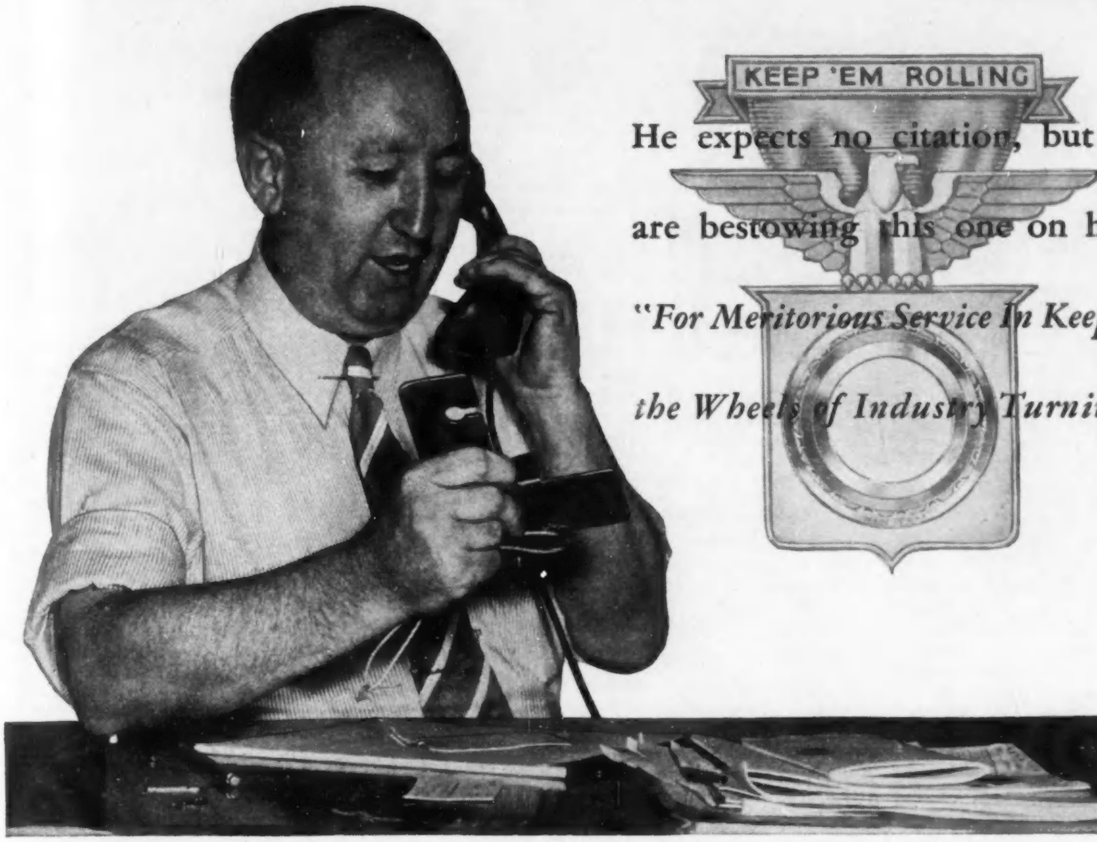

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Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Davis, William Tilden, technical writer, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Kantor, William, The Durham Co., New York City.

Leach, Frank William, National representative, The Texas Co., New York City.

Mohnen, Charles, field engineer, Heyer Products Co., Inc., Belleville, N. J.

Murphy, Charles J., plant layout man, Lawrance Engineering & Research Corp., Linden, N. J.

Peacock, Donald R., designer, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Pohlmeyer, Vincent D., service engineer, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Ridle, Homer J., mechanical engineer, General Laboratories, Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.

Rowold, Henry, manager, national accounts department, Mack-International Motor Truck Corp., Long Island City, N. Y.

Scharf, Herbert, aviation equipment inspector, U. S. Army Air Forces, Materiel Division, Newark, N. J.

Scott, Lewis Leonard, plant foreman, The Davis-White Corp., Larchmont, N. Y.

Seifried, Paul E., draftsman, Sperry Gyroscope Co., Inc., Garden City, N. Y.

Sergeant, Lucile H., Miss, technical assistant, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Smith, Allen Edwin, assistant supervisor, Socony-Vacuum Oil Co., Inc., Brooklyn, N. Y.

Smith, Emanuel Harold, test engineer, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Smith, Karl B., Jr., technical correspondent, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Smith, John C., senior test engineer, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Tuman, Cazimia, junior test engineer, Wright Aeronautical Corp., division of Curtiss-Wright Corp., Paterson, N. J.

Vester, Wilbur R., experimental engine tester, International-Plainfield Motor Co., Plainfield, N. J.

Watkins, Clarence Arthur, industrial specialist, WPB War Agencies Section, Automotive Branch, Washington, D. C. Mail: 63-109 Saunders St., Forest Hills, N. Y.

Winter, Paul H., service and sales engineer, E. R. Merrill Spring Co., New York City.

Woodruff, Robert William, draftsman, International-Plainfield Motor Co., Plainfield, N. J.

Milwaukee Section

Bostrom, Karl, partner, Bostrom Mfg. Co., Milwaukee.

Kopatzke, George A., branch manager, Wagner Electric Corp., Milwaukee.

Shaw, Jos. C., engineer, aircraft products division, Young Radiator Co., Racine, Wis.

New England Section

Breen, John Edward, automotive sales engineer, Gulf Oil Corp., Boston.

Hodgdon, Charles William, supercharger tester, River Works, General Electric Co., Lynn, Mass.

Northern California Section

Connolly, John Alban, planner, machine shop, Moore Dry Dock Co., Oakland, Calif.

Crawford, John G., automotive instructor, U. S. Army, War Department, Ordnance Motor Transport School, Stockton, Calif.

Firey, Joseph C., research engineer, Standard Oil Co. of Calif., Richmond, Calif.

McIntyre, Donald R., development engineer, Atlas Imperial Diesel Engine Co., Oakland, Calif.

Roberts, Maurice R., diesel instructor, Salinas Evening School, Salinas, Calif.

Northwest Section

Craney, Oliver W., service engineer, Washington Iron Works, Seattle, Wash.

Oregon Section

Grenfell, Edward William, superintendent of delivery and transportation, Meier & Frank Co., Portland.

Meany, J. M., manager, logging department, Loggers & Contractors Machinery Co., Portland.

Philadelphia Section

Lewis, William Dein, test engineer, Diesel Engine Division, American Locomotive Co., Auburn, N. Y. Mail: 160 Wyoming St., Carbondale, Pa.

Weiss, William H., service engineer, The S. K. Wellman Co., Cleveland, Ohio. Mail: 104 Sabine Ave., Narberth, Pa.

St. Louis Section

Dutton, Walter E., Lt., editing officer, U. S. Army, St. Louis Ordnance Motor Transport Supply Depot, St. Louis.

Farnstrom, Carl O., laboratory technician, Shell Oil Co., Wood River, Ill.

Southern California Section

Bajkowski, Frank Walter, junior stress analyst, Lockwood Aircraft Corp., Burbank, Calif.

Baker, John Morris, liaison engineer, Douglas Aircraft Co., Inc., Santa Monica, Calif.

Benfer, Vernon B., group head in charge of technical training, Lockheed Overseas Corp., Burbank, Calif.

Cameron, Harold J., engineer, Douglas Aircraft Co., Inc., El Segundo, Calif.

Champion, Albert Prosper, project liaison engineer, Lockheed Aircraft Corp., Burbank, Calif.

Correll, Theodore T., assistant superintendent of shop, Pacific Motor Trucking Co., Los Angeles.

Crooks, Homer L., design draftsman, C. F. Braun & Co., Alhambra, Calif.

Hagelin, Willard Ernest, general manager, Hagelin Aircraft Motors Co., Glendale, Calif.

Harvey, Bruce Eugene, senior detail, powerplant, Lockheed Aircraft Corp., Burbank, Calif.

Hooper, Otis, factory superintendent, Kanig Mfg. Co., San Gabriel, Calif.

Miller, Robert Lafe, safety fleet engineer, General Insurance Co. of America, Los Angeles.

Milmoe, Robert, research engineer, Lockheed Aircraft Corp., Burbank, Calif.

Pickens, L. W., sales engineer and representative, Aeroquip Corp., Los Angeles.

Pyeatt, Anthony Dewitt, supervisor of production illustration group, Douglas Aircraft Co., Inc., Los Angeles.

Rein, Frank Keys, mechanical engineer, Douglas Aircraft Co., Inc., El Segundo, Calif.

Revelle, Carl K., test engineer, Studebaker Pacific Corp., Los Angeles.

Spier, Edward Ellis, Jr., stress analyst, Northrop Aircraft, Inc., Hawthorne, Calif.

Statler, William H., junior weight engineer, Lockheed Aircraft Corp., Burbank, Calif.

Tonkin, Robert William, engineer, Douglas Aircraft Co., Inc., El Segundo, Calif.

Wassall, John Brent, chief engineer, Vega Aircraft Corp., Burbank, Calif.

Wood, Wilbur G., chief engineer, Menasco Mfg. Co., Burbank, Calif.

Southern New England Section

Swenson, Arthur Bernhart, experimental test engineer, Pratt & Whitney Aircraft, division of United Aircraft Corp., East Hartford, Conn.

Syracuse Section

Morrows, Wendell W., repair machines, Savage Arms Corp., Utica, N. Y.

Towers, Albert, vice president and charge of procurement, Balch-Morris, Inc., Seneca Falls, N. Y.

Texas Section

Biggers, Hope, senior aircraft inspector, U. S. Department of Commerce, Civil Aeronautics Administration, Fort Worth, Texas.

Estill, Fayette William, production planner, Consolidated Aircraft Corp., Fort Worth, Texas.

Johnsen, W. H., owner, Technical Chemical Co., Dallas.

Lapham, John A., leadman, materials group, tooling and planning department, Consolidated Aircraft Corp., Fort Worth, Texas.

Washington Section

Harris, John R., fleet superintendent, Richmond Newspapers, Inc., Richmond, Va.

Outside of Section Territory

Barnwell, James A., director of maintenance, Associated Transport, Inc., Burlington, N. C.

Crane, Jack J., Lt., U. S. Army Air Forces, A. P. O., c/o Postmaster, New Orleans, La.

Fall, Harry W., research engineer, Caterpillar Tractor Co., Peoria, Ill.

Henderson, R. D., research engineer, Caterpillar Tractor Co., Peoria, Ill.

Jacoby, Edward M., service engineer, Sealed Power Corp., Muskegon, Mich.

Klinge, Earl R., assistant professor, Pennsylvania State College, State College, Pa.

Mahoney, Charles Hallam, chief of metallurgical control, Basic Magnesium, Inc., Las Vegas, Nevada.

Miller, George Dewey, Dewey Miller Garage, Huntington, W. Va.

Murphy, Timothy Henry, superintendent of Diesel power, American Locomotive Co., Schenectady, N. Y.

Osborne, G. Harold, supervisor, Kendall Refining Co., Bradford, Pa. Mail: 28 Cambridge Road, Albany, N. Y.

Peet, Orville S., equipment supervisor, Department of Public Works, Bureau of Highways, State of Idaho, Boise, Idaho.

Pennington, John Wesley, laboratory engineer, Caterpillar Tractor Co., Peoria, Ill.

Foreign

Lewis, Richard Bullock, liaison weight control engineer, Civil Aeronautics Administration. Mail; c/o Panagra, Limatambo, Lima, Peru, S. A.

Mautner, Frantisek Leopold, technical engineer in laboratory, Armstrong Siddeley Motors, Ltd., Coventry, England.

Thomsett, Leslie Clarence, technical assistant, Ministry of Aircraft Production. Mail: c/o Resident Technical Officer, Rolls Royce, Ltd., Derby, England.

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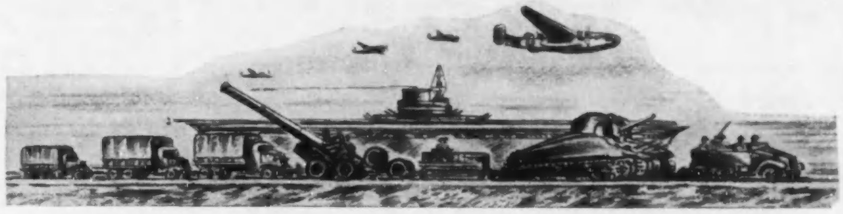

News of the
JANUARY
Issue

WAR ACCELERATING DEVELOPMENT OF BETTER VEHICLES AND FUELS

WORLD WAR II, with its annoying handicaps to civilian use of motor vehicles, appears to be the direct, if tremendously expensive, means to the ends of better motor vehicles and motor fuels. While the war is diverting the Nation's automotive assets largely to military requirements, simultaneously it is accelerating new automotive developments which normally would require years to accomplish.

For instance, petroleum engineers already are talking about the "ultimate" gasoline; they say that even now the fuel is theoretically possible, and indicate it can be made – at a price. More appropriate, they insist, is the development of automotive power plants which, through better manifolding and better control of fuel mixture and spark advance, will take better advantage of the characteristics of motor fuels already available. They indicate this will be one happy result of war experience.

Prospects for production of the "ultimate" gasoline and of the more advantageous use of present fuels will be described in the January issue of the *SAE Journal* by W. M. Holaday and John Happel, of Socony-Vacuum Oil Co., Inc. They explain that gasoline, like the automobile engine, is composed of possibly thousands of parts. The parts of gasoline are known as hydrocarbons, but comparatively few as yet have been identified, isolated, or classified as to effect upon engine performance.

Enough already has been learned, however, to give the gasoline refiner control over some of the many gasoline characteristics in which consumers are interested, such as octane number, which contributes to knockless performance and full-power output; vapor pressure, which assures freedom from vapor lock; and distillation, which makes for ease of starting, proper warmup, good acceleration, and minimum crankcase dilution. Describing the various refining processes now used, the authors reveal how petroleum refiners rebuild and rearrange hydrocarbon molecules of crude oil to make satisfactory gasolines, and, as rapidly as learned, put new knowledge to use in the continuous effort to solve the problem of making a motor fuel which satisfies the demands of minimum price, maximum performance, and adequate volume.

By Norman G. Shidle

Censorship

Welcomes a Will to Win

The American press is still free to be useful.

Censorship may limit, but does not impede, the exchange of wartime technical information among tens of thousands of engineers working in thousands of war plants today. Current industrial and engineering publications rank higher in hard-headed, practical information than did their peacetime issues.

Engineering society meetings can be equally free to disseminate the vast developments in materials, design methods and production techniques which the Army and Navy are counting on to win this war.

But all freedom has a price.

What is the price of freedom to hold better-than-ever engineering society meetings in wartime?

Briefly, it requires utmost effort by authors, their companies, and engineering societies to get approval for presenting technical material calculated to advance knowledge in the war-engineering field. Individual difficulties will be the rule rather than the exception. Apparent inconsistencies in rulings will irritate the engineering mind. Occasionally hard-spawned data will have to be buried at birth.

But this is a small price for engineering societies and their members to pay for the chance to hold meetings badly needed in the war effort. To American engineers and their professional organizations, "all-out" must mean nothing less than "all-out."

By their actions since Pearl Harbor, Government censorship agencies have shown clearly that they *want* to see the exchange of vital technical data continued. Engineers and their societies must take the responsibility for any major curtailment in the effectiveness of engineering meetings. That is one thing the Government and its censorship agencies can't be blamed for.

Let's look at the record - particularly as written in dealings with the more-potent-than-ever technical and industrial press.

Government censorship agencies, in general, will release papers and articles which are of vastly more value to the United Nations' engineers than to the enemy. That yardstick is wholly practical. Here are some salient attitudes which play an important role in today's American censorship of engineering and production material:

1. Government officials are sincerely anxious to have technical information about engineering, production, and maintenance continued. Know-how in munitions factories is as important as combat strategy, and

2. Government censors are conscientious, serious, and reasonable. In return, everyone participating in meetings planning must be just as

February

The February issue will report the SAE WAR ENGINEERING PRODUCTION MEETING and SAE 1943 Annual Meeting

WATCH FOR IT

SAE Journal

conscientious, serious, and reasonable in:

1. Choosing the most informative subjects and the best possible authors;

2. In cooperating with those men in the Army and Navy designated to protect technical information, and

3. Accepting, as part of the cost for continued freedom, those rulings required by wartime censorship.

This, of course, adds greatly to the normal peacetime effort and energy required to operate successful engineering society meetings – and will add extra hours on the effort of society members and editorial staffs alike. Everyone – management, engineers, and societies' staffs are overloaded these days – but this is only a minor item of the cost of war.

Engineering meetings are essential to winning the war. It is the plain obligation of companies, engineers, and society staffs to raise the standards of these meetings. That obligation is a challenge to vigor, to resourcefulness, and to plain, unadorned horse sense.

Censorship can function only on specific manuscripts and illustrations. That means *some* work must go for nothing, because the censors cannot pass judgment on generalities. Every paper is an individual and a specific case. Therefore:

1. Authors must take an active part in getting their own papers cleared;

2. Their companies must help in some cases, and

3. Engineering society staffs must be ready to assist upon occasion.

Only a positive approach can succeed. The idea that "it can't be done" must be eliminated at the outset. With an eye to victory, authors and staffs must undertake to render the technical services for which engineering societies were organized in the first place.

The Society of Automotive Engineers is doing just this with positive, energizing, and stimulating meetings. May history never record a letdown – particularly now when the armed forces of the United Nations so desperately need all of the functions of the SAE . . . functions and services which already have gone far to solve armament production problems, and which will be needed more abundantly during the dark months ahead.

War Engineering Cooperation Wins

COOPERATION for the national war effort already is beginning to pay real dividends in the way of compilation of human knowledge and experience. Among these dividends are compilations of service data which should enable the Nation to keep its commercial motor vehicles rolling for the duration, and even to improve their operating efficiency.

The January issue of the *SAE Journal* will present the first of a series of 30 or more detailed reports now being prepared by the Maintenance Methods Coordinating Committee of the SAE Transportation and Maintenance Activity, for the Office of Defense Transportation.

This first report deals with the technique of installing and fitting replacement engine bearings and – like the other war transportation conservation reports being prepared by this group at ODT's request – is replete with data heretofore available in no one shop, yet now accessible to all who repair or operate commercial vehicles.

Treat Metals to Resist Corrosion, Take Paint

ANODIZING, chromatizing, and phosphatizing have been found effective in preparing metals for painting and welding operations, as well as direct methods for expediting manufacturing operations. Weekly average of spot welds has been increased to 850 from 450 per welder per hr, the number of assemblies completed per week stepped up more than 34%, simply by such advance treatment and preparation of metal that all soil and oxides are removed, the surface made uniform.

These processes, now widely used in aircraft manufacture, will be described by Ray Sanders, general manager of Turco Products, Inc., in the January issue of the *SAE Journal*. Mr. Sanders explains in detail how various metal surfaces may be protected against corrosion and how highly reactive metals may be passivated to render surfaces suitable for paint adhesion.

It Isn't the Smoke, It's the Aldehydes

PUNGENT odors from motor-bus exhausts which irritate eyes and noses of passengers and pedestrians alike have been traced to the aldehyde content of exhaust gases. A slight reduction in that content corrects the situation, but making that slight reduction is an engineering job which borders upon mechanical dilemma.

Improvements have been made by changing engine manifolding, raising intake-mixture temperatures, installing high-temperature manifolds, thinning idling mixtures, and using more volatile fuels. Helpful also has been the installation of mechanical devices which cut out fuel or ignition during deceleration. Unfortunately, every remedy seems to create new ills in the way of increased fuel consumption, reduced power, or ineffectiveness under certain conditions.

The whole story of this automotive puzzle will be told in a special article by J. J. Mikita, Harry Levin, and H. R. Kichline, all of The Texas Co., to be published in the January issue of the *SAE Journal*. They include a discouraging report on the fallibility of the human nose, which can sense discomfort but is so hopelessly unable to evaluate it as to be no help at all in devising a remedy.

AUTOMOTIVE ENGINES VITAL IN WAR

TOTAL mechanized war has assigned the internal-combustion engine to tasks demanding efficient, consistent, and continuous functioning anywhere in the world under all operating conditions. With minimum time for maintenance and repairs, and none to call upon the factory for new parts, engine failure is fatal in combat or production.

All of which is preliminary to the fact that American automotive engineers, taking the situation in their stride, are paying more attention to piston rings, inconspicuous but important parts which now can mean the difference between victory and defeat. The objective is to "keep 'em running," and means to this end are revealed in two special articles on piston-ring design, construction, and use which will be published in the January issue of the *SAE Journal*.

One is by Macy O. Teetor, of The Perfect Circle Co., who says that while piston rings have the separate tasks of controlling compression and of controlling oil consumption, they must function cooperatively for best results. He commends the ventilated oil ring having narrow cylinder-contacting flanges with a spring behind it, as most effective for so controlling oil that there is enough to lubricate and to seal the compression rings, but no excess. Insufficient control means waste of oil, he says, excess control results in unnecessary wear.

Proposing that rings be selected for the tasks assigned to them, Mr. Teetor explains that cylinder temperatures, compressions, and cylinder wall and ring materials all are highly critical factors. So far, cast iron seems to be the most satisfactory ring material, with cast-iron alloys showing promise; and new materials, plus surface treating, affording hopes for future improvement both of rings and cylinder walls. Mr. Teetor describes experiments which have demonstrated that oil consumption in a 220-hp engine can be reduced to 1,300 hp-hr per gal from 407 hp-hr per gal, and scuffing, cause of excessive wear, largely eliminated.

The second article, by F. Glen Shoemaker and Rex Allbright, of the Detroit Diesel Engine Division of General Motors Corp., is concerned specifically with positive control of oil consumption in 2-cycle diesel engines. These authors place economy second to preventing excessive oil deposits on engine parts, explaining that ultimate service life of reciprocating parts in all types of engines is determined by the build-up of these deposits. Temperature of the parts and quantity of oil reaching them are said to influence the rate of build-up; to lubricate piston and compression rings sparingly is to postpone trouble.